Engineering News-Record

A Consolidation of Engineering News and Engineering Record
McGRAW-HILL PUBLISHING COMPANY, INC.
MAY 10, 1917

Sierra Nevada Snows Made Difficult Construction of Rush Creek Hydroelectric Plant in California

Described in This Issue

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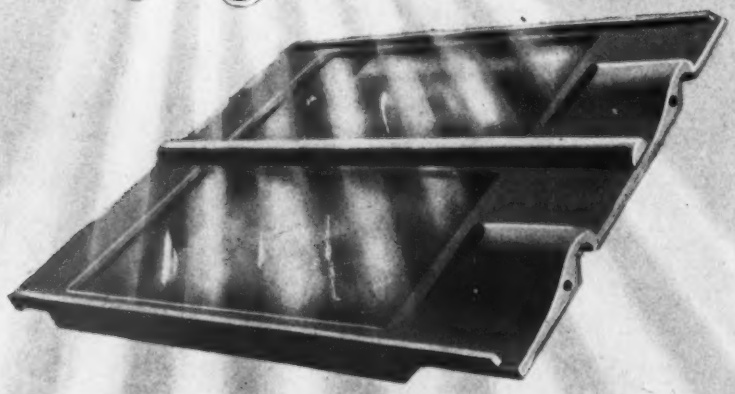
The Daylight Roof



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Twin Mixer Plant Places Five Thousand Yards of Winter Concrete Each Month

Site Requires Two Separated Mixer Plants—Materials-Heating Shed, Canvas Curtains and Salamanders Keep Concrete from Freezing

ONE of the largest and fastest jobs of winter concreting in the country has been under way during the past winter on the new building for the American Can Co., at Maywood, Ill., about 12 miles west of Chicago. Of the estimated 30,000 cu.yd. of concrete on the job, 22,000 cu.yd. were poured in the four winter months after the work started last November. In order to do this amount of work under such conditions, many novel plant features and construction methods were developed.

Plant Layout Fitted to Available Ground

As shown in the general layout in Fig. 1, the building is some 265 x 575 ft. over all, with the long way running east and west. On the north is the Illinois Central R.R., with several sidings available for construction materials. On the south there is a street with car tracks. To the east is another building, a part of the American Can Co. plant. The only open ground is therefore to the west.

This open ground is used for storage of materials. Cement sheds, mixers, etc., are sandwiched between the railroad sidings. These are near the center of the building, leaving the corner where the vacant ground joins the railroad tracks as the logical place for a good-sized derrick. This serves to unload material from cars and to hoist things up onto the building.

An industrial track runs from under the big derrick to the center third (north and south) of the building. This part at the west end is not full height, the concrete stopping at the first-floor level. It is therefore feasible to run the industrial track on the first floor nearly to the center of the building east and west.

Two lumber hoists, one on each side of the open center portion, hoisted steel and forms brought in on the industrial track. A third lumber hoist located on the street opposite those inside took care of material coming from that direction.

Construction work was started at the east end, and this part has been kept a step ahead of the west portion. This plan works out very well with the arrangement of hoists and derricks. A small stiff-leg is set up on the upper level wherever required to relay the material already hoisted to the lower west-end level.

Concrete Placed by Towers and Carts from Two Mixers

There are two mixing plants along the railroad tracks to the north. They are of very different design, but they both furnish concrete to towers running only a little above the top of the building. The concrete is hauled in two-wheeled carts to wherever placing is going on.

It was found during the early part of the work that placing of concrete with chutes was not satisfactory during cold weather. The mixed concrete not only became thoroughly chilled, but if at all stiff refused to go through the chute properly. The use of carts was therefore taken up and has proved satisfactory.

The main mixing plant is of the gravity bin type loaded by belt conveyors and bucket elevators and using

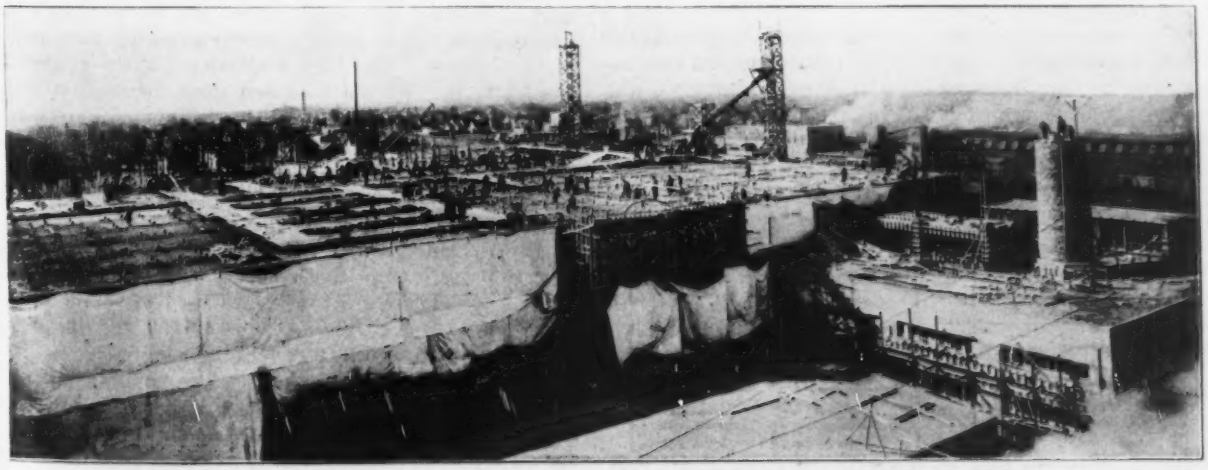


FIG. 1. AMERICAN CAN PLANT ARRANGED FOR WINTER CONCRETING

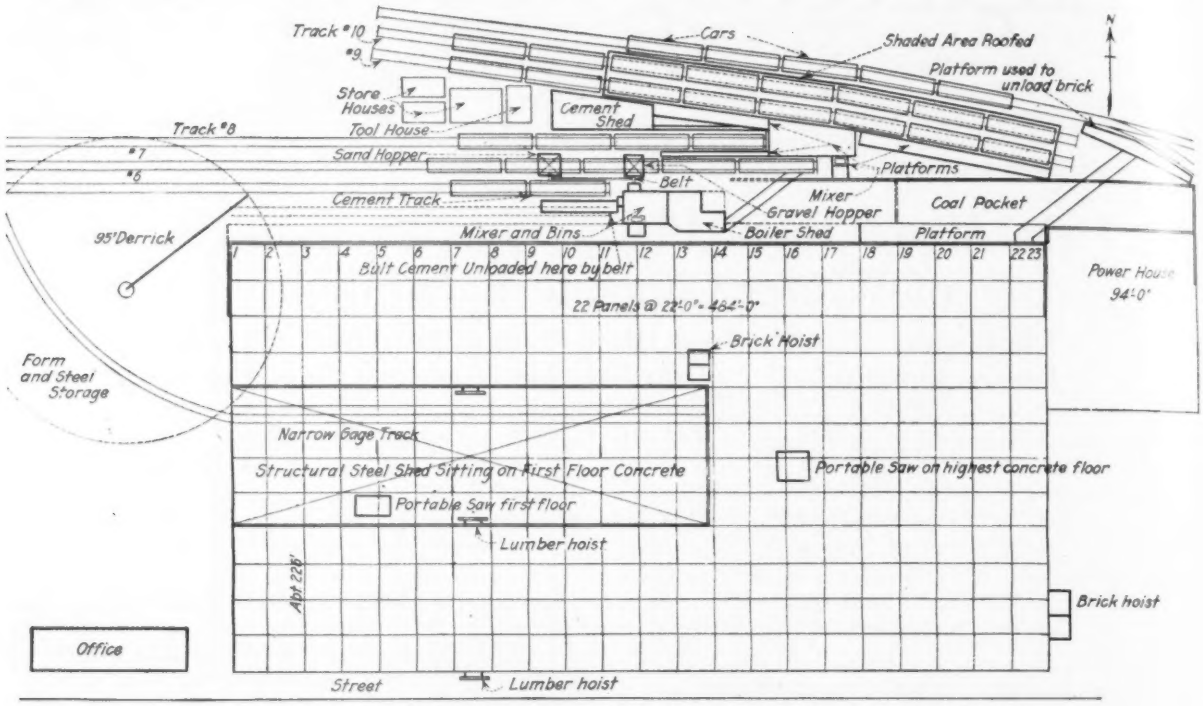


FIG. 2. CONSTRUCTION PLANT OF NEW AMERICAN BUILDING, AT MAYWOOD, ILL.

bulk cement. The auxiliary plant consists of a mixer charged by wheelbarrow from a level elevated platform, and a closed-in shed of 12-car capacity with steam pipes and radiators to keep it warm and a steam line with connections for jets for thawing cars of frozen material quickly.

The bins of the main plant are built of 2 x 6's laid flat and supported by bolts running across the bins where required. A detail of the dovetail corner is shown in the sketch of the mixer plant in Fig. 5. The bins are carried by heavy timbering on trench jacks.

The cement elevator is on the west end of the bins, while the one for sand and stone is on the north. The bins are split up as shown in Fig. 5, the sand and stone elevator dumping where those two bins join. The material flowing into one or the other is controlled by a hinged board tongue at the mouth of a forked chute having one leg in each bin.

The measuring hoppers are built together, quite as the bins themselves are. As bulk cement is used, the cement-measuring hopper is kept closed in to prevent flying of the dust. A window in one side at the top and an electric light inside enable the man at the lever to see when his hopper is filled up to the mark. Gates in the bottom of the measuring hoppers drop the charge through another hopper into the 1-yd. mixer below, which discharges into a bucket in a tower. The water is measured in a tank on top of the mixer.

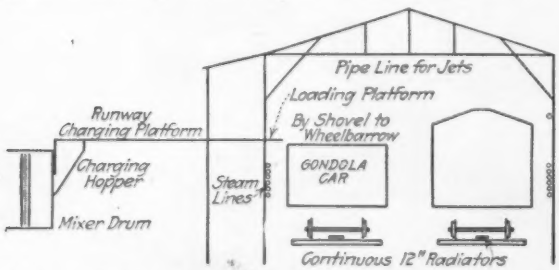


FIG. 3. SECTION THROUGH STEAM-HEATED SHED FOR MATERIAL CARS

The unloading of material cars into the bins is done by belt and bucket conveyors. The track hoppers are over belt conveyors that deliver their contents to a vertical bucket elevator beside the bin. The near hopper is usually used for stone and the far one for sand. As there is only one elevator, but one can be unloaded at a time.

Cement-Handling Arrangement

The arrangement for handling and elevating the bulk cement is shown in Fig. 4. It consists of a hopper fitting close beside a railroad box-car and discharging onto a belt conveyor. The hopper is loaded by wheelbarrows running on the box-car floor. It is interesting to note that in loading the wheelbarrows the scoop shovels are used with a slicing action, thereby avoiding the suction of the cement. The bucket elevator for the cement is similar to that for the sand and stone, but not so large. Also, it runs higher and discharges into a chute going diagonally into the cement bin. This diagonal-chute arrangement makes it possible to leave the elevator near the tracks on the wall of the sand compartment of the bins.

In this plant the sand and stone are heated by steam pipe running around the bin sides at vertical spaces of about 3 ft. There are two boilers used to supply steam for both concrete plants. One is of 100 and the other of 120 b.-hp. An average crew for the big mixer consists of nine men, as follows: One at stone gate, one at sand gate, one at cement gate, one at water and discharge levers, one at clearing spout, one at operating hopper gate, one on top of tower, two engineers. The crew to unload material consists of one engineer, six men unloading sand

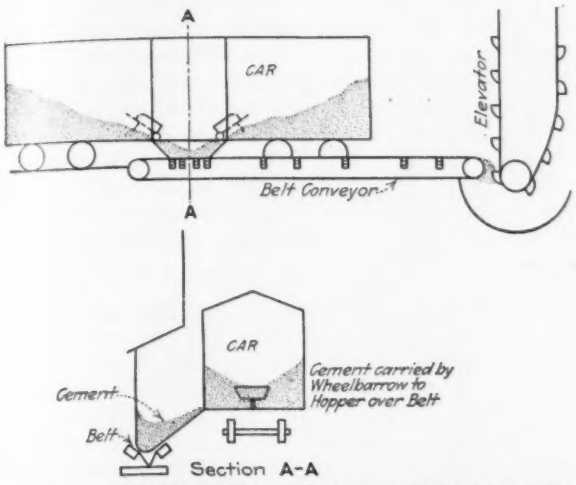


FIG. 4. DETAIL OF HOPPER AND CONVEYORS FOR UNLOADING BULK CEMENT

and gravel and two men unloading cement. The record 8-hour run with this mixing plant is 515 cubic yards.

The mixer of the auxiliary plant is charged from a platform on a level with the tops of gondola cars on the nearby tracks. As shown in the general layout plan (Fig. 1), a shed was built over two of these tracks, making it possible to inclose 12 material cars for heating (Figs. 3 and 6). The heat is supplied by steam pipes along the sides of the shed and by two rows of 12-in. radiators on the ground. One end of the shed is boarded up except for a small doorway, and the other end was closed with a canvas when heating was required. A line of pipe along the outer wall has openings to attach steam jets for thawing out the cars quickly. As it is necessary to throw a considerable portion of one side of the shed open when mixing concrete, it is not possible to keep the shed very warm during the work. When the shed may be closed, however, it gets very warm. As high as 110° with the outside temperature at 10° below was obtained when heating was carried on over night.

To load the wheelbarrows, they are run up close to the cars in the shed. The men shoveling stay at all times in the cars, while the wheelers stay with their barrows. The crew used at this mixer runs as high as 50 or 60 men at times. On a day when 43 were on the job they were distributed as follows: Three wheeling cement, two opening and dumping cement, two bundling cement sacks,

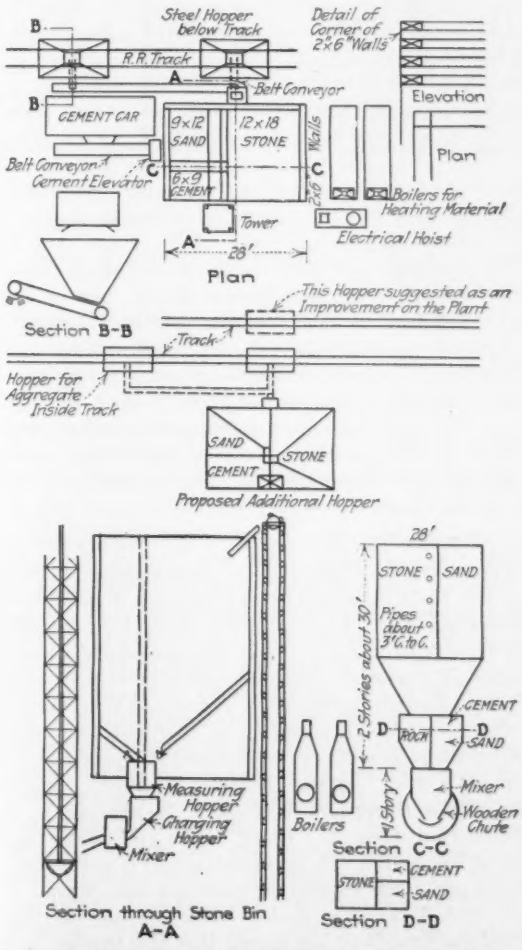


FIG. 5. DETAILS OF MAIN MIXING LAYOUT OF MAYWOOD PLANT OF AMERICAN CAN CO.

FIG. 6. STEAM-HEATED SHED FOR MATERIAL CARS AT 110° F. IN FREEZING WEATHER

four wheeling sand, four shoveling sand, eight wheeling rock, sixteen shoveling rock, one watching charging hopper, two dumping mixer, one cleaning out under bucket.

The ground being of course solidly frozen, it was necessary to thaw it out and warm it up before concrete could be placed with the expectation of having it set up quickly enough to carry the weight of the building to be placed upon it. The holes for each footing were filled with water, and the water was heated with live steam. In this way the ground was effectively thawed around the hole and received enough warmth to last a long time. The tops of the footing when concreted were covered with 12 to 15 in. of straw. This was found effective in keeping them reasonably warm.

During the cold weather the newly poured concrete in the structure was protected by canvas curtains placed around the floor below and by a covering of more than a foot of straw over the top of the concrete. Salamanders of the usual type were placed under the new floor and fired until the concrete was properly set. In the most severe weather three or four were at times required.

When a man has built a plant and used it successfully, his ideas as to how it could be bettered are of especial value. In this case the superintendent suggests two main betterments—one for each of the concrete plants:

On the main plant it has been found that unloading material is often troublesome, because it can be dumped on only one track. By putting a hopper under the second track from the bins and running a conveyor under it, greater speed and convenience could often be obtained. This scheme is shown in Fig. 5. It is considered that the auxiliary plant could be improved by making the shed a little wider and building a runway between the two tracks. With a few movable bridges twice as much material would be made available without switching the cars.

At the time when the roof had just been started, there were 860 men at work for the general contractor, Thompson-Starrett Co., in the daytime and 120 at night. W. F. Vatter is superintendent for the contractor. The cement finish is being put on as a subcontract by the Builders Material and Supply Co., of Kansas City.

To Pave Over New York Subway with Sheet Asphalt

Fill Over Broadway Tubes Will Require Five Years To Settle—Asphalt Preferred Under These Conditions

THE fill over the recently finished section of the Broadway (New York) subway, extending from Vesey St. to 14th St., varies from 8 to 20 ftfl in depth. Composed mainly of sand and rock from the excavations, complete settlement, it is estimated, will probably require five years. In the interim, however, the roadway must be paved so that the rehabilitation of the street as a business thoroughfare may be accomplished with no extension of the delay already caused by the disturbance accompanying the construction of the tube.

The southernmost section of the subway, between Vesey and Bleecker Sts., has been finished more than a year; the temporary granite blocks being laid from Bleecker St. north to 14th St. during the fall of 1916. No attempt was made to establish a permanent roadway except between the surface-line tracks, which are solidly supported on concrete piers resting on the roof of the tube. The specifications of the Public Service Commission required that the old granite blocks be relaid temporarily between tracks from Vesey St. to Bleecker St., but from this point north they demanded asphalt.

Expect Settlement for Five Years

The distance from rail to curb varies from 12 to 15 ft. —too long a span to expect any construction of reasonable cost to bridge without failure under even moderate traffic. Subjected to the pounding of motor trucks of several tons rating, which serve the jobbing houses of this section, or the occasional passage of moguls of extreme capacity, subsidence would have been inevitable. To have laid a concrete foundation even of moderate thickness in the expectation that it would crack and settle in large slabs, would merely have been a temptation to use a better wearing surface than the circumstances warranted.

But aside from these considerations, there was this additional point to be considered: The rehabilitation of Broadway will no doubt result in the construction of many new buildings, and the consequent continual disturbance of the foundations. Everything, therefore, favors delay in the construction of an expensive foundation. The problem, thus simplified, left the decision between wood block, granite block and sheet asphalt—since asphalt blocks are no longer laid in the Borough of Manhattan—the selected type to be laid without concrete base.

Most Factors Point to Sheet Asphalt

As a deciding factor, life was not considered, since reconstruction, from subgrade up, must be undertaken as soon as the fill has completely settled. Silence was the main argument advanced for wood block; in the case of improved granite block, the advantage to trucking. The advocates of sheet asphalt based their preference on low first cost, feeling that the growing preponderance of motor trucks made the quality of silence a negligible factor, and urging that parallel streets paved with granite could be used without undue inconvenience by heavy horse-drawn vehicles.

Furthermore, to relay the old granite blocks, or to lay the new improved granite blocks, would have necessitated a complete readjustment of the foundation. Wood block of ordinary depth would have meant the removal of the present temporary surface, 3 or 4 in. of sand fill, and would result in a pavement of little inherent stability. To lay wood blocks on the surface of the temporary granite blocks was out of the question. In any case, the original cost would have been higher than the purely temporary nature of the construction warranted. As an additional and final factor, the Bureau of Highways has learned from experience that the asphalt surface is by far the easiest to maintain over fills. In fact, all repair to asphalt-block pavements is made with "hot stuff."

The roadway, now paved with the old block relaid on a bed of sand, has been maintained by the subway contractors for the contract period of six months. This surface is at present very uneven, and will require much resetting before being cleaned and washed preparatory to laying the wearing sheet. Minor unevennesses will be adjusted and the surface brought to 3 in. below grade and section with binder, portland-cement concrete not being considered as desirable on account of cost and the length of time necessary for its setting.

Binder and Top Laid at 30 Penetration

Very much like the Topeka Specifications as to grading, the 1½-in. binder will run between 5 and 8% of 30 penetration A.C. Laid as stiff as this, it is not felt that any trouble will result from the occasional areas that, having an excessive depth of asphaltic-cement concrete, might ordinarily be considered susceptible to waving.

The 1½-in. top, running 10 to 12½% of 30 penetration A.C., will gain stiffness from the 17% portland cement used as a filler. Major Eugene W. Stern, chief engineer of the Bureau of Highways, Manhattan, is of the opinion that under the heavy traffic and continual dripping of lubricating oils this penetration is not unduly low. Cracks are much simpler to maintain than waves, in any case, and experience under traffic similar to that expected on Broadway has shown that the trouble to be expected from this source is negligible.

Build Subway Station Beneath Philadelphia's Massive City Hall

Concrete Girders Flanking Old Footing Walls Used To Carry Loads to Walls of New Subway—Sectional Construction and Restricted Space Make Work Difficult

TO PERMIT the construction of a four track subway station beneath it, the foundation walls of the massive City Hall in Philadelphia are being flanked with pairs of steel or concrete girders carrying the ends of needles passing through the walls and transferring the weight of the building permanently to the new subway structure. These girders and the rebuilt basement floor of the City Hall will form the roof of the subway station. This new underpinning process is accomplished by excavating alongside the old rubble-masonry footing walls; replacing them where necessary with concrete or brick work, embedding in this the I-beam needles; placing on each side of the old wall the new concrete or steel girders; excavating under the ends of the girders wood-sheeted pits in which pipe piles are driven to rock and sections of the new subway walls constructed; taking the load of the new girders on these wall sections, and finally excavating the remaining earth cores, thereby transferring the building-wall loads from the soil to the girders and completing the underpinning.

With this section are also being constructed under-crossings beneath the present Market St. subway on both sides of the City Hall, the work being accomplished by constructing the new subway walls in sections, replacing the floor of the old subway with the roof of the new and completing the work in the same way as that under the City Hall proper. The old basement is cut up by heavy walls into small rooms, and a great deal of the 25,000 yd. of trench and pit excavation required in transferring the weight of the building to rock has to be hoisted by hand and carried to the shaft skips in wheelbarrows. Excavation has to be carried on simultaneously at many scattered points, and the existence of the old basement walls makes it impossible to lay much industrial track or install hoisting equipment under the building itself.

After the new walls are in, however, the remaining 41,000 yd. of core excavation can be taken out much more economically by modern methods. The concreting for the underpinning work must also be carried on at a disadvantage with portable mixers at the street level, frequently moved chutes in the basement and hand wheeling. Being in a congested district, the excavation is disposed of and the construction materials are largely delivered to the site by motor truck.

Poor Mortar in Old Footings

The Philadelphia City Hall, built in the early '70's, is very massive, and its footings are estimated to load the gravel on which they rest at about 8 tons per sq.ft. These footings were thought to be of rubble masonry laid up in lime mortar; but when they were uncovered, it was found that the mortar was either lacking or in very poor

condition. In one place it was possible to look clear through a wall about 3 ft. thick into the adjoining room. These conditions made it necessary to replace this masonry before needling it and placing the flanking girders.

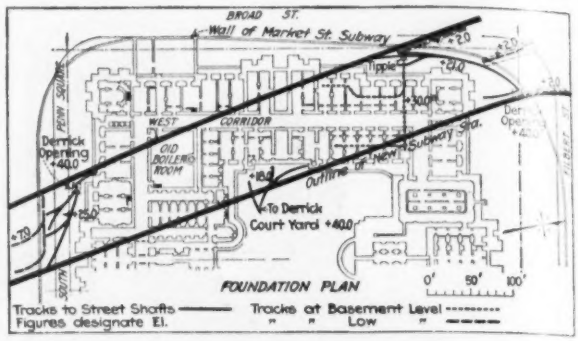
Both brick and concrete were tried for replacement; and while there was no difference in the cost with walls up to 30 in. thick, the concrete showed a marked advantage in cost for thicker walls and was finally adopted for all. During this replacement work the masonry above was shored for the longer spans, but this work presented no great difficulties, the masonry in the entire building above the footings being in unusually excellent condition.

Contract Divided Because of Difficulties

Because of the necessity thus developed for extensive replacement of the old footings, construction of the flanking girders and a large yardage of excavation under poor conditions, it was decided to divide the original contract into

OLD FOOTINGS, LACKING MORTAR, REQUIRED REPLACEMENT

two sections, leaving the south half to be completed by the Keystone State Construction Co., the original contractor, and reletting the northern half. This contractor, however, was successful bidder for the northern half, known as section 102, and is now carrying out this section as well as section 101, with separate organizations.



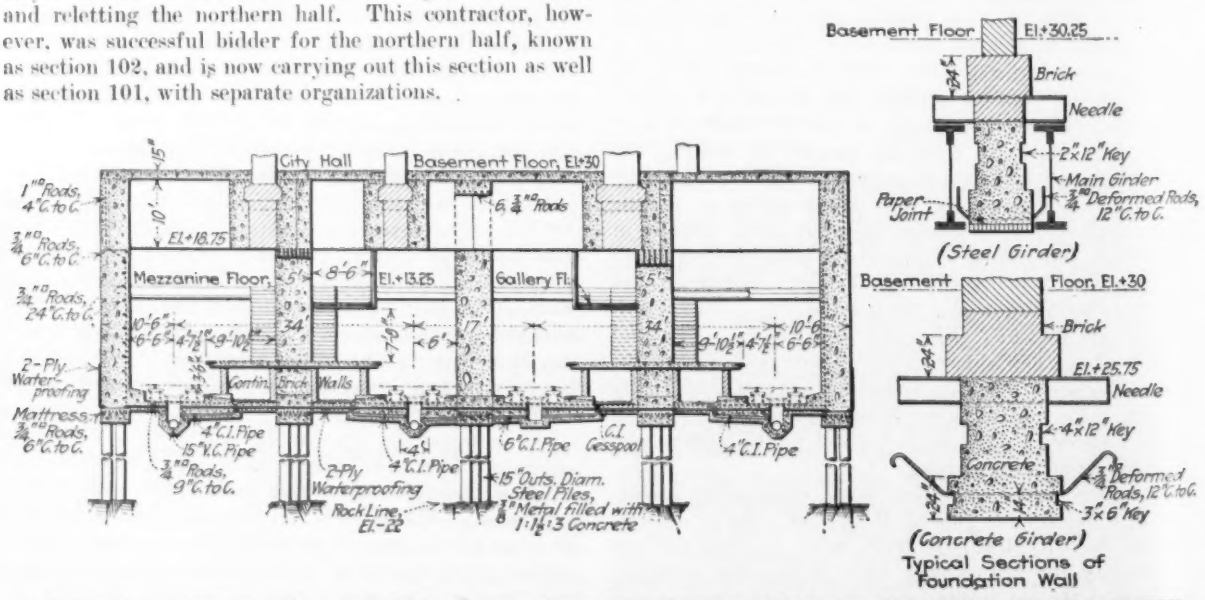
USE OF INDUSTRIAL TRACK IS LIMITED

The way in which the needles are embedded in the new footing masonry is plainly shown in the drawings and photographs. The next step is to place the heavy reinforcing for the flanking girders and erect the side forms for them.

Small Portable Mixers Required

Three ½-yd. mixers are being used to carry on the concrete work for both sections. On the south section, one of them was located in the old boiler room of the City Hall, where a considerable yardage was to be poured, after the boiler installation had been moved to a new location built by the subway contractor under the northeast corner of the building. Except for the work in this one room, however, there was no opportunity for handling the mixers economically at basement level, and they are set up at various convenient points on the sidewalks and in the court, where they can be supplied from material piles dumped by motor truck. Holes are cut through the sidewalk and the concrete is spouted to place where possible. If the distance is too great for spouting with the available headroom, the concrete is carried in buggies.

As the chutes have to be carried around corners at many places, most of them are of wood, built in place. Of



EACH OLD FOOTING WALL IS NEEDLED AND GRIPPED BETWEEN STEEL OR CONCRETE GIRDERS, WHICH WILL TRANSFER ITS LOAD TO SUBWAY WALLS

some 2300 yd. of old masonry to be replaced with concrete in this way, about 80% has been completed, while the concrete girders will require 5500 yd., of which perhaps one-third is in place at present. The walls of the new subway structure amount to 12,000 yd., the only portion of which yet placed is the concrete in the tops of the walls constructed under the old subway on the south side of the building and that in 25 of the wall pits which have been concreted.

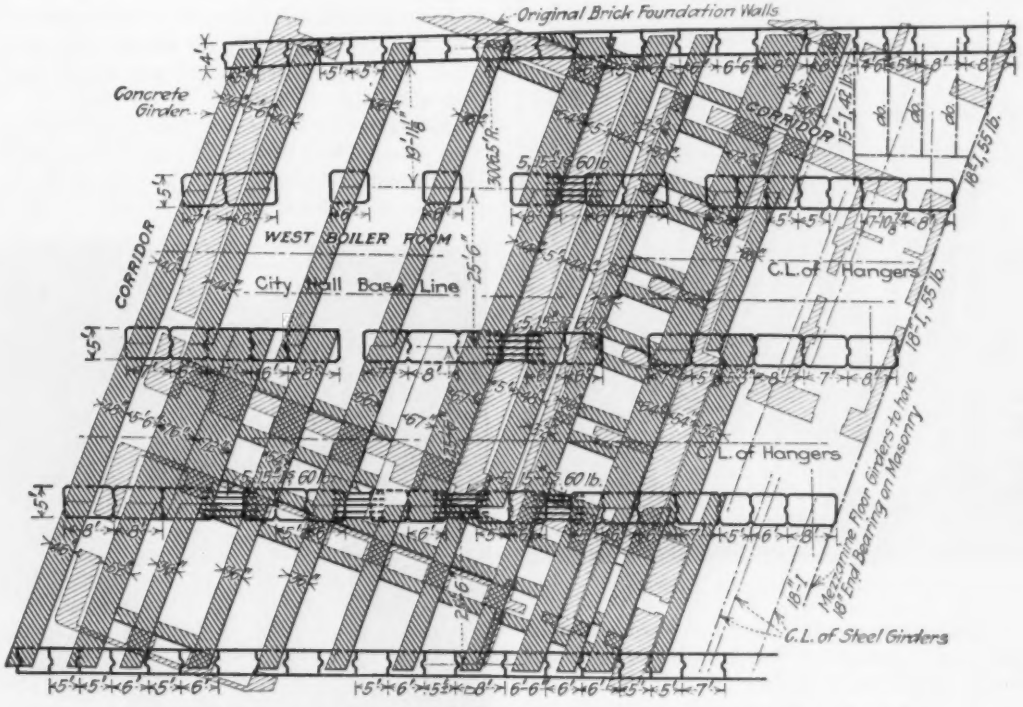
Roof of New Subway Replaces Floor of Old

The undercrossing beneath the south branch of the existing Market St. subway was begun by constructing the top portions of the new subway walls beneath the old structure in drifts. The loads from the old subway are transferred to these walls by a new steel system, consisting of heavy columns, which carry the old subway roof on longitudinal girders, and the new floor of the old subway by a girder and floor-beam system similar to bridge practice. This new floor forms the roof of the new subway. The new steel was erected and riveted, the new floor concreted and the changes in the existing subway structure completed before work was started on the wall pits underneath the top wall sections to transfer the load to rock. The new floor steel for the old subway was placed one panel at a time during the early morning hours, when traffic could be carried on one of the two tracks.

With the north branch of the Market St. subway a different plan is being pursued, and the new subway walls and supporting piles will be constructed completely in sectional pits before the old structure is disturbed. It is believed that this method will give greater speed and economy and will possibly prevent delay in taking out the earth core under this portion simultaneously with that on the rest of the work. This might occur if the new wall construction were put off till after the tedious work of reconstructing the old Market St. subway had been completed.

Large Yardage of Earth Handled in Buckets and Wheelbarrows

The sand, gravel and old masonry excavated in underpinning the old walls are necessarily handled at high cost, because there is no space to operate modern equipment in the small rooms and narrow corridors of the old basement. Although the yardage is considerable, it is impossible to develop the work so that there is any great quantity of excavation coming from any one point at one time. All the spoil is transported in wheelbarrows or in ½- and ¾-yd. buckets on platform cars to 1½-yd. skips at one of the shafts. The large skips never leave the shafts, the wheelbarrows and small skips being dumped into them under ground. The material is hoisted and dumped into bins, from which it is drawn through gates into motor trucks. All the wheelbarrow transportation is by the most direct route on plank runways in the old basement to the nearest shaft or track.

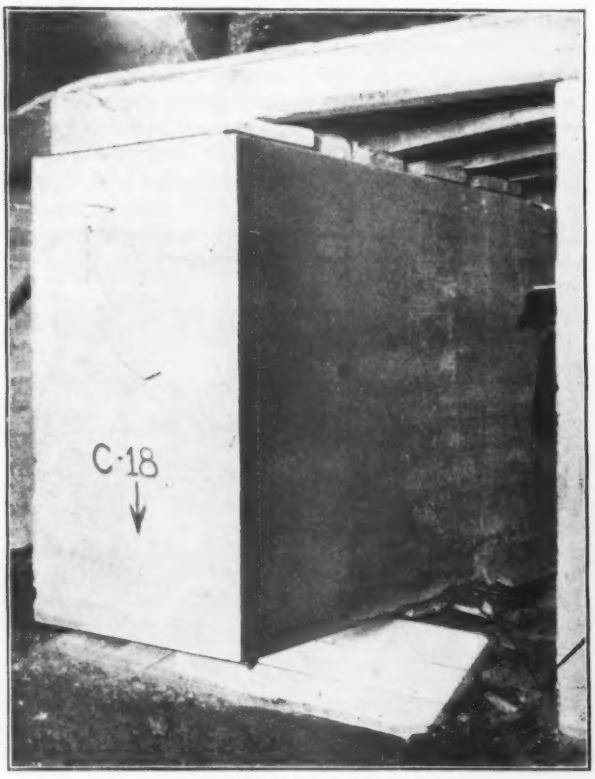


PLAN OF SMALL SECTION SHOWS HOW NEW GIRDERS FLANK OLD WALLS

The narrow-gage tracks on which the ½- and ¾-yd. buckets are handled on platform cars are in six sets and on three levels. Those on the middle level, between El. +18 and El. +25, reach the shafts. The track system on the highest level, which takes care of the excavation from a portion of the basement on section 102, carries cars that dump on a tipple into buckets on the middle track system reaching the shaft at the northwest corner of the building. The track systems at the lowest level are at present extended only beneath the Market St. subway on either side of the City Hall. Small electric trolley cranes, running on I-beams over the shaft openings and operating a two-part fall of ⅞-in. wire rope, raise the buckets

from cars on these lowest tracks and land them on cars running to the street shafts. These hoists are entirely out of the way and save much room, the only drawback to their use, it is said, being that they are very slow in operation.

The three main shafts used so far for disposal have been located in the courtyard and at the north and south



WALL PIT BENEATH END OF GIRDER

sides of the building on the sidewalk. A fourth shaft has recently been opened on Broad St., just south of the Market St. subway at that point.

Driving of Pipe Piles Impeded by Boulders

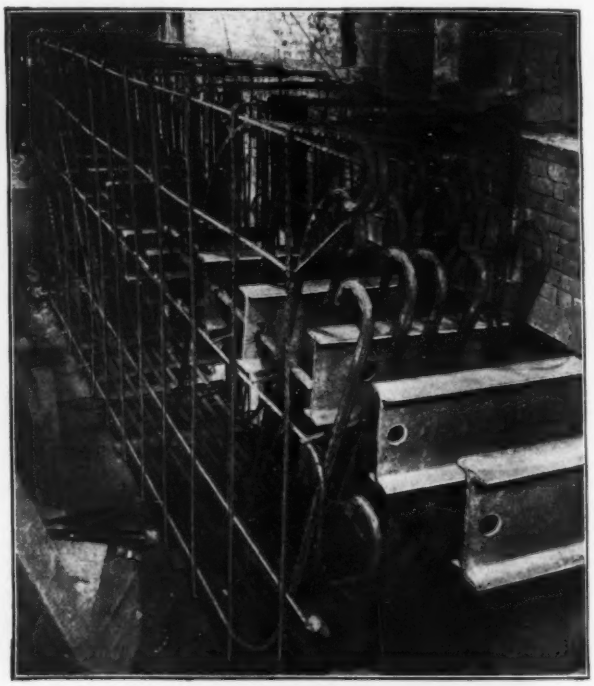
The pits sunk for constructing the wall sections are approximately 5 x 6 ft. in plan and are lined with horizontal 2-in. plank having beveled notches along both upper and lower edges, through which sand can be packed behind the sheeting. In a few pits grout has been tried, but is not generally necessary. The bottom of these wells is at El. —5.25, about 7 ft. below groundwater level. The rock lies at El. —22, and the walls will be supported by 15-in. pipe piles filled with concrete. The number of these under each wall section varies from 4 to 13, according to the load. Where pits are sunk under the ends of completed flanking girders and it is possible to secure reaction for jacking, this method is used in driving the piles. Most of them, however, are being driven with a No. 6 McKiernan-Terry air hammer. A penetration of 50 blows to the inch is recorded as the piles reach rock, which is a mica schist. The piles secure such a firm bearing at the bottom that only two of them have leaked, after being cleaned out, sufficiently to require a seal of mortar under water before they could be pumped dry and filled.

Each pile is designed to carry 90 tons, and they are tested to about 110 tons, which is the limit of the strength of the jacking timbers that can be set in the average well. One empty shell bearing on rock stood a pressure of 70 tons without settlement. In the driving, boulders have been struck which caused much trouble and have made it impossible to get many of the piles down to rock. When a pile is stopped in this way, another is driven in its place.

These boulders have been attacked with a shot drill working through the piles, and attempts made after several holes had been put through a boulder to break it and force it aside by dropping in the pile an 8-in. diameter steel ram 10 ft. long. This method, however, has met with little success, and it is proposed to try light blasting.

Organization of Disposal and Material Supply

The excavated material and much of the cement, aggregates, steel and other supplies are being handled to and from the work on subcontract by Stedman Bent, with White motor trucks. Most of the spoil is being disposed of at South Philadelphia over a 5-mile round-trip haul. The contractor's forces estimate every night the probable quantity of material to be excavated on the succeeding



FLANKING GIRDER HEAVILY REINFORCED

day, also the quantities of aggregate, etc., required at the work, and requisition a sufficient number of trucks to take care of this traffic.

The work on both sections of the City Hall station is being carried out by the Keystone State Construction Co., under the direction of the Department of City Transit of Philadelphia, W. F. Twining, director, and Henry H. Quimby, chief engineer. The construction work is in charge of Frank R. Fisher, engineer of subway construction, and Dion Martinez, principal assistant engineer. For the contractor William P. Parker is superintending engineer.

Spore-Forming Lactose Splitters Get Water-Supply Into Trouble

Sacramento Finds Less Chlorine Necessary, but Old Pollution Requires Closer Methods of B. Coli Indentification

LESS overdosing of water-supplies with chlorine will be practiced when the latest laboratory methods of tests for B. coli are better known. This is particularly true when the ordinary test is applied to waters having a comparatively old pollution where, by the gradual reduction of the actual B. coli and the survival of the spore-forming lactose splitters, like B. Welchii, the latter assume preponderating importance in the B. coli test. This knowledge is not new; but water-works superintendents who have experienced continued complaints of tastes and odors from the alleged use of too much chlorine may find they can safely cut down the dose, just as Sacramento did, the experience of which with the Sacramento River, from studies of the city laboratory and the State Board of Health, is noted below.

Small Dose Kills B. Coli

Examination indicated that the true B. coli, the real index of pollution, was killed by a much smaller dose than had been applied and that had been considered necessary because the ordinary presumptive tests still showed positive. A large amount of study was given to a particular spore-forming bacterium, B. Welchii, found in the lower Sacramento River, and technique was worked out in the following manner to eliminate it from the B. coli group:

Two 10-c.c., two 1-c.c. and two 0.1-c.c. portions of the water are planted in fermentation tubes containing lactose peptone broth and incubated 48 hours at 37.5° C. From each tube showing gas, streaks or smears are made on the surface of litmus lactose agar plates and again incubated for 24 hours at 37.5° C. The development of typical aërobic red B. coli-like colonies should be considered sufficient evidence of the presence of the B. coli group.

Colonies that appear doubtful should be fished and transplanted into a lactose-broth fermentation tube and incubated 48 hours at 37.5° C.; the presence of gas indicating one of the B. coli group. The theory of the enrichment method and the subsequent smears on litmus lactose agar is that most of the anaërobic forms will not grow on the latter media.

Reduction of Chlorine at Sacramento

The effect of the intensive bacterial study at Sacramento was to permit the reduction of the amount of chlorine from 2.6 lb. per 1,000,000 gal., an amount on the border of producing complaints of tastes and odors, to from 1.5 to 2 lb., well below the complaint point.

L. D. Ehret, superintendent of the water-works, makes all the tests on the spot except those for bacteria, which are carried out by Dr. T. Lyman in the city laboratory. The State Board of Health work was done under the direction of C. G. Gillespie, director of the bureau of sanitation, by Frank Bachmann, chemist and bacteriologist for the bureau.

THIS WATERSHED NEEDS MORE TREES

Hillsides in Union County, Pennsylvania, most of which have too sparse tree growth for protection of watershed

Pennsylvania Water-Works Reforest Catchment Areas

State Department of Foresty Arouses Interest and Supplies Trees at Shipping Cost

AS A PART of a general reforesting campaign, Robert S. Conklin, Pennsylvania state commissioner of forestry, recently urged the management of each water-works in the state to plant trees on portions of their catchment areas not useful for agriculture. The plan followed was to send to each water-works a statement of the reasons for reforesting, with a blank return card designed to show planting possibilities.

To water-works that replied favorably to the first letter, a second one was sent, offering to send a forester to examine land and to supply a planting plan to any water-works "sufficiently interested" to consider reforesting of five or more acres annually "and also offering to furnish seedlings at bare cost of packing and shipping, which averages about 50c. per 1000 seedlings delivered." At the same time a bulletin on "Reforesting Pennsylvania's Waste Land—What and How to Plant" was mailed to the responding water-works.

Of 547 water-works to whom return cards were sent (one sending, only), 219 reported. These were divided into 103 having land that should be planted and 116 owning no land or else no land that required planting. To the offer of seedlings virtually without charge, 26 water-works (to Apr. 17) applied for a total of 446,100 young trees, for use on about 230 acres. Most of the 77 other water-works that had expressed interest stated that adverse labor conditions were against reforesting work this spring, but hoped to begin next year.

Inspect California Grade Crossings

Of a total of about 10,000 grade crossings on California railroads, approximately 2000 had been inspected and reported upon by the engineering department of the State Railroad Commission up to Jan. 1, 1917. The cost to the commission of this work has been approximately $2.40 per crossing. The survey will be extended to cover every grade crossing in the state.

Silt Settled from Power Stream To Prevent Turbine Erosion

Success in Eliminating Abrasive Permits Using Francis Turbines Where Impulse-Wheels Were Destroyed

By J. W. SWAREN

Pelton Water Wheel Co., San Francisco

ELABORATE settling ponds were completed some years ago by the Pacific Power and Light Co., on its White River hydro-electric development in northern Oregon. Impulse wheels had previously been installed, but had been badly eroded by silt. They were replaced by Francis-type turbines (in the course of improvements following the consolidation of several properties of which this was one) and no abnormal wear has been found.

White River is essentially glacier fed and flows from the southern flanks of Mt. Hood, where the soil is decomposed lava and highly absorbent so that the runoff is stabilized. The normal flow is 175 sec.-ft. and the minimum (in autumn) 180 sec.-ft.

The stream may be running crystal clear, and in a few minutes will turn milk white with highly abrasive silt carried in suspension. On other occasions, when the glacier gives up organic débris, the stream turns a dull red. Because of these occurrences and the suddenness with which the changes take place, it is necessary to filter all drinking and transformer cooling water.

Two Ponds Are Connected By Pipe

The development was made at White River Falls where 140 ft. head was created. The diversion dam is 200 ft. above the falls and is a concrete structure, set zigzag across the stream. It is 360 ft. long with a spillway notch 120 ft. long by 2.25 ft. deep. Standard rack-and-pinion gates admit water into the first settling chamber, which is 140 by 50 ft. in area and 10 ft. deep. One side of this chamber is formed by the hard lava ledge, another by the dam, and the remaining two are of concrete. The instream wall is surmounted its entire length with wooden flash boards having an effective height of 4 ft., while a waste gate for ice disposal, with a clear area of 5 ft. x 4 ft. 3 in. is set in the downstream wall. Trash racks, made from 1½ x 6-in. wood pipe staves, protect the entrance to the outlet pipe. A wood grating platform, extending to these racks, provides a place for men to remove ice and snow during the ice season. A portion is covered by a shed 25 ft. long and 8 ft. wide, for protection of the men from driving storms.

Wood-Stave Pipe

A wood-stave pipe line 60 in. in diameter and 526 ft. long, leads to a second settling chamber formed by throwing a concrete dam across the mouth of a small gorge just below the falls. This dam has a maximum height of 31 ft. and a total length of 161 ft., 52 ft. of which is a spillway section filled with flash boards 3 ft. high, made of 6 x 6-in. timbers, set against timbers placed in sockets cast in the concrete. The crest width of the spillway is 5 ft. 3 in. An additional 20 ft. of the dam crest is occupied by an ice wasteway, and spanned by a building housing the operating gear for the outlet and sludge gates.

An opening, 30 in. diameter, at the lowest point of the dam, serves as a sludge gate. It is closed by a flap valve which does not obstruct the flow when opened and is controlled by a windlass gear. Wooden trash racks, made from 6 x 1½-in. pipe staves, protect the penstock entrance.

A 60-in. penstock, 381 ft. long, leads to the power house set in the river gorge just below the base of the falls. The upper 270 ft. is continuous wood stave, the remainder riveted steel plate ¼ in. thick. It terminates in a riveted steel manifold held in concrete anchorages alongside the power house. The penstock and the pipe line connecting the settling chamber are protected from weather by a corrugated steel wood framed shed structure, designed to carry snow load.

The power house is a masonry structure set on a shelf blasted from the canyon wall. The original installation consisted of two 900-hp. impulse type wheels, direct connected to 500-kw. generators, operating under an effective head of 126 ft. The penstock led directly from the dam. Much abrasion resulted from the silt in suspension, the rivet heads of the wheel casings were destroyed, rivet holes were eaten away until leakage was continuous at every seam; buckets had a life of only a few months, and even the shaft was damaged. Silt abrasion reduced this from 8 in. to 3 in. diameter, where it passed through the housing, in less than 6 years' operation.

Settling Has Eliminated Wear

After the settling basins were built, two Francis-type turbines replaced the impulse wheels. The new turbines were coupled direct to the original generators. In spite of extreme burden of silt during the last four years, it was not found necessary to make any replacements of guide vanes or runners until six years of service had been given. A careful study was made of the erosion marks on the vanes, casings and runners, and new designs were developed from the light of these investigations.

In addition to the two units just mentioned, a third Pelton-Francis turbine, rated at 2100 hp. and direct connected to a 1250 kv.-a. generator, was installed two years later. The last unit is designed for an effective head of 137 ft. The other two were designed for an effective head of 126 ft., the same as that of the old impulse wheels. As this took no account of draft head, these turbines, rated for 900 hp., develop in excess of 1000 hp.

The data from which this article has been prepared was furnished to the writer by J. C. Martin, chief engineer, and B. P. Baily, manager for the Pacific Power and Light Co., at The Dalles, during an inspection trip made in the interests of the Pelton Water Wheel Co. contractors for the hydraulic equipment.

Another Water Company Bought Out

One by one the privately owned water-works of the country are being acquired by the cities they supply. By a vote of 8 to 1 the electors of Charleston, S. C., recently decided to pay $1,360,000 for the works of the Charleston Light and Water Co. Valuations placed on the works were $1,375,742 by John H. Gregory, New York City, for the municipality and $1,675,000 by John W. Alvord, Chicago, for the company, the values being as of Jan. 1 and May 1, 1914, respectively. On Dec. 14, 1915, the people voted against paying $1,500,000 for the works.

I-Beams, Forming Main Verticals of Bulkhead, Make Hard Driving Into Limestone

In Port Terminal at Jacksonville Some Steel Beams Driven as Piles Curled Up Under Hammer—Main Difficulties Relieved by Subsurface Blasting

By HERBERT D. MENDENHALL
Consulting Engineer, Jacksonville, Fla.

THE bulkhead wall of the new Commodores Point Terminal wall on the St. Johns River at Jacksonville, Fla., is of steel sheet piles tied into 12-in. steel I-beams spaced every 30 in. and driven solidly into the limestone river bottom. While some of the I-beams curled up in the almost unbelievable shapes shown in the accompanying views, by far the greater number (1686 out of 1700 driven) were sent down safely; and by a loosening up of the subsurface by blasting, all were finally driven to fairly accurate line and grade.

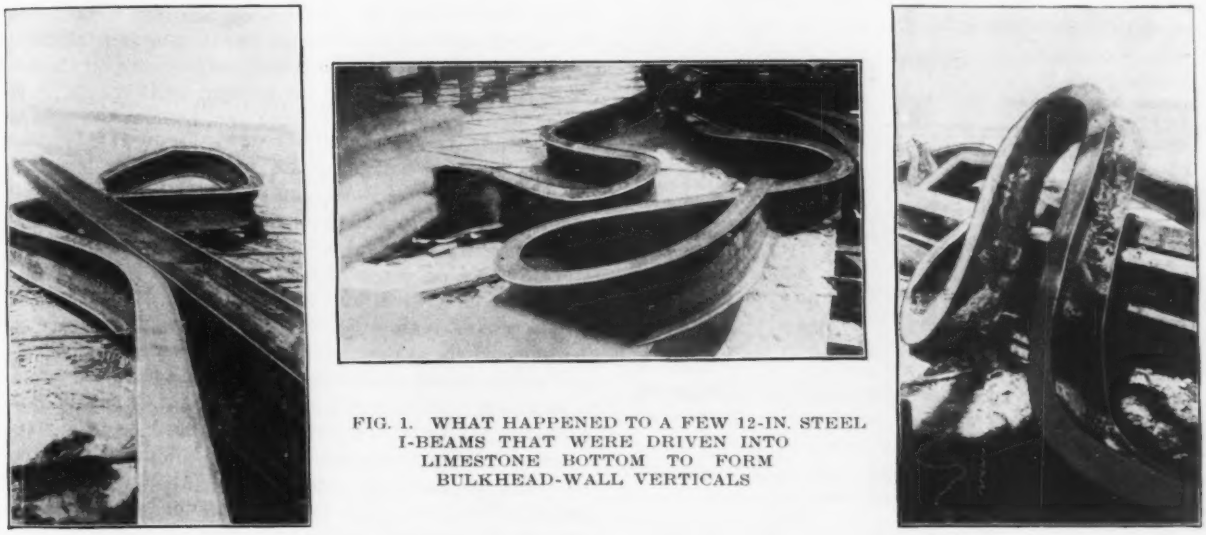


FIG. 1. WHAT HAPPENED TO A FEW 12-IN. STEEL I-BEAMS THAT WERE DRIVEN INTO LIMESTONE BOTTOM TO FORM BULKHEAD-WALL VERTICALS

The design of the whole bulkhead was described in *Engineering News*, Oct. 21, 1915, and the sheet-pile driving in the same journal, Feb. 8, 1917.

Bulkhead Is Sand-Fill Behind Steel Wall

As shown in Fig. 2, the wall is designed to hold back a fill of 34 ft. of sand, 30 ft. of which is below mean low tide and 4 ft. above. The resistance to sliding at the toe and about 75% of the section modulus of the wall are provided for in the beams, and impermeability is obtained by the continuous row of Wemlinger steel sheet piles driven 1 ft. into rock immediately back of and interlocked to these beams. The resistance to overturning is carried by tie-rods every 3 ft. running from a horizontal wall at the water surface back to a braced pile anchor system.

The tops of the sheet piles theoretically are left 1 ft. above mean low tide and the beams 3 ft. below; but as a fact the piles are left somewhat higher than the theoretical, for sufficient penetration into rock to effect a seal at the toe was all that was desired, and as a rule this was obtained before the theoretical depth was reached. Extra hammering of the sheet piles was avoided for fear of distorting them. The contrary held in driving the beams. If they penetrated the rock at all, they did so with comparative ease; and as the need for a firm footing was kept ever present in the mind of the inspector, he would usually insist on a few extra blows with the hammer even after the theoretical grade was reached. As a result, practically all beams are slightly below what was actually called for.

Hard Limestone Strata Underlie River Bottom

Along 4300 ft. of the wall, rock in which to secure the bottom of the beams existed at varying depth. For the remaining 864 ft. there was no rock, and other means of securing the toe were resorted to. The rock encountered was in the main a porous shell limestone of varying degrees of hardness and decidedly stratified. The hardest strata, the ones that stopped the progress of the beams, were tough and of a flinty nature. The successive strata averaged about 12 in. in thickness with about 18 in. of soft material between. The soft intermediate material varied from a soft quality of the same shell limestone to a sort of hardened mud that dissolved under the water jet. Sand and clay overlay the rock in thicknesses of from 2 to 25 ft., excepting for a stretch of about 500 ft., where the rock was entirely bare at a depth of about 24 feet.

The beams were driven with both a steam hammer and a drop hammer at different times. The steam hammer was a No. 1 Vulcan with a McDermott base and a 5000-

lb. moving part making a 42-in. stroke and delivering 70 blows per minute. The drop hammer was a standard 3000-lb. cast-steel type.

The first 25 or 30 beams were driven with the steam hammer, and all came up hard at the limestone stratum 30 ft. down. It was then decided to try the drop hammer, and this was found more effective, due doubtless to the chiseling effect of the blow. Even then the beams would not penetrate the hard stratum in every instance, so it was decided that the only way left was to drive all the beams to refusal and then drill and blast under the toe

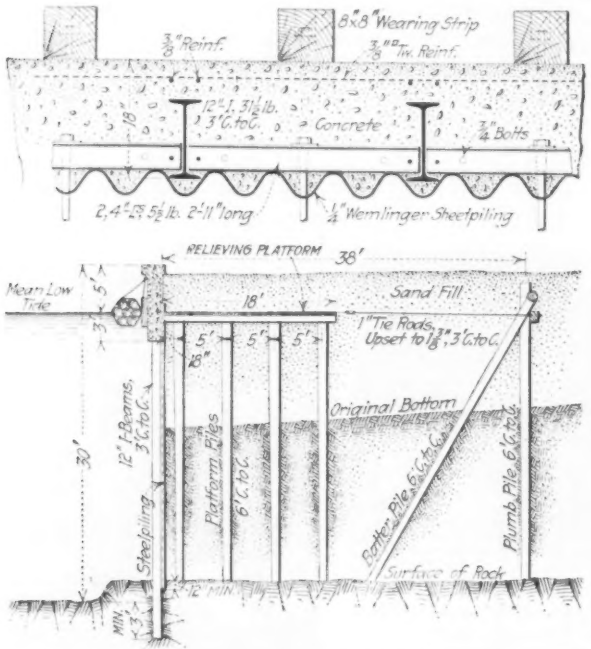


FIG. 2. BULKHEAD FOR JACKSONVILLE PORT TERMINAL OF SAND-FILL BRACED AGAINST STEEL WALL

in order to break up the hard stratum. The remaining preliminary driving was done with the steam hammer, as the patent head left the top of the beam in better shape for future operations.

Some Beams Curled up Against Hard Bottom

In about 75% of the cases little trouble was encountered in driving the beams. In these instances the hard strata were simply too thin or not sufficiently hard to prevent the breaking through of the beams. In the remaining cases the beams would stop on some one of the various hard strata, sometimes going through three or four of them before stopping and at other times stopping on the top stratum. Where a deep bed of sand or clay overlay the rock, it was found that the beams would penetrate the rock more successfully than when the rock was bare, due doubtless to the lateral stability given the beams by the sand enabling them to stand heavier driving.

It was early decided that the driving of the beams would have to be facilitated by a water jet to relieve the friction. This was prompted by the experience in placing the sheet piles. But after the first few had been driven, it was found that the jet was not necessary. This is partly accounted for by the fact that there is only about 44 superficial inches in the cross-section of the 12-in. I-beam as against about 66 in the sheet piles, and then the beams offered considerably more resistance to upsetting and bending in driving than did the sheet piles.

At the bare place mentioned, where there was no overlying sand, the swift currents had also eroded the soft rock from the top, leaving only the first hard stratum exposed. Along this stretch practically no penetration whatever could be gained on the initial driving, and a number of the beams bent under the driving. Some of these beams, after they were pulled, are shown in Fig. 1. These cases were discovered during the initial driving. The beams were being set in place in the clips and given a few blows to set them and also to determine if they would penetrate at all, when the inspector noticed that in a few that apparently had penetrated there was a peculiar springy motion as the driving progressed. Having his suspicions aroused, he examined below the water surface with a long straight-edge and discovered that, instead of penetrating, the beams were simply bending sidewise or curling up at the bottom while being held tight in the three top clips. After this discovery great care was maintained not to drive too hard when resistance of any magnitude was encountered.

Subsurface Blasted

As already stated, where the beams refused to penetrate the rock, blasting had to be resorted to in order to crack the strata. In this a succession of experiences developed. As a preliminary test of the needs, a small hand-operated drilling apparatus was developed. It was composed of a light A-frame on a pontoon, a small gasoline-driven 1½-in. force pump delivering water through a ¾-in. hose and pipe to a combination jet and drill. The drill jet was manipulated by a rope passing through a block at the apex of the A-frame. A 2-in. casing would be jetted down to the rock, and then the drill jet would be jigged up and down inside the casing until the hard stratum was penetrated. Dynamite would then be let down through the casing to the proper measured depth and there exploded. The amount of dynamite to use had to be determined by experiment, but at first was severely limited by the proximity of the bottom of the sheet piling and beam.

After about 25 beams had been thus "shot," the pile-driver was brought back and another trial at driving made. This test developed that most of the beams would penetrate the specific stratum blasted, but would stop on the next one below. This indicated that a mere makeshift of a drill rig would not be sufficient; and so first a four-battery hand-drill rig was built, and still later a steam drill was put into use. With these various apparatus about 450 beams were drilled and blasted. Timidity as to size of shot to use soon disappeared, and before the end a load as long as the stratum was thick would be set off with no apparent damage to the wall. The dynamite would be packed in tin tubes made for the purpose and of proper length to let down the measured distance. Each stratum had to be shot separately, beginning with the bottom one and working up. Even with this elaboration of shooting, some holes had to be reblasted three or four times before the beam could finally be driven to grade.

Shearing of Beams

Following the first redriving after the first blasting, an interesting phenomenon developed. When the hammer was started on a few of these beams, the penetration would

seem normal and satisfactory for perhaps a dozen blows. Then the same suspicious springiness would become apparent, and driving would be stopped. When the beams were pulled later, it was discovered that the blast set off had simply punched a hole in the rock under one flange, leaving the remainder of the stratum intact. When redriving started, the beam would shear, permitting the flange to go straight while the web and the other flange would crumple and curl up. When the crumpling progressed to a sufficient degree, usually about 24 in., the springiness would begin to show up with the subsequent discontinuance of the driving. Heavier charges of dynamite in each shot were then resorted to. In one case this led to some rock being blown out under the sheet piling, and a leak of sand-fill resulted.

How Bent Beams Were Replaced

Those beams so bent as to require replacing had first to be located. The records and memory of the inspector were a guiding light in this, but the final test came by carefully lowering a long straight-edge from the water surface to the bottom just alongside the beam. This would always show conclusively if a beam were bent, even though the method was somewhat tedious. Then came the problem of removing the beams found bent. The piledriver leads were adapted to this by reeving the steel pile line through a triple block to give the pulling power, fastening a 1-in. log chain to the beam and developing a leverage by using a 16-in. pine pile with the short end resting on the relieving platform and the long end taking the pull from the triple blocks.

In several instances the sheet pile to which the beam was interlocked would also come up. In such a case it would be pulled up a sufficient distance to expose all the clips that still engaged the beam flange, when a section would be cut from the flange with an oxyacetylene cutting torch, releasing the beam and allowing it to swing free. The beam would then be swung up onto the relieving platform for future consideration. In nearly every instance the beam was found to have sprung out of all but the top three clips, equivalent to about 10 ft. below the water surface. After the beam was cleared and laid out, the sheet pile would be redriven to grade.

As there were only nine new beams on hand to replace the fourteen that had to be taken out, and as steel shipments were practically nonexistent, the straight parts of the removed beams were utilized. These sections, 15 to 20 ft. in length, were cut off by gas torch and were spliced together or to new lengths to form the new sections to be driven.

Some Difficulty Found with Clips

The clips with which the beams were interlocked to the piling were made up from ½-in. pressed-steel plates 9 in. long and fastened to the sheet piling with three ¾-in. rivets. The clips were spaced approximately 5 ft. apart along the entire length of the sheet piles. The object of these clips was to cause the beam and piling to act integrally as one beam.

In driving, the sheet piling were driven first, being lined against the guide wale of the relieving platform. The beam-driving hammer followed at a convenient interval. The only difficulty found in interlocking the beams and the piling was in the occasional tightness of the clips. If the top clips happened to be the tight ones, they could easily be sprung out with a bar; but various subterfuges had to be resorted to in order to enter the lower clips. Fortunately, the corrugations in the sheet piles served as guides and went far in making easy the problem.

After making several trials it was found that, when the first two sets of clips were passed and the beam rested on the third set, a light tap with the hammer would force the beam through. The friction in the clips was sometimes so great that the combined weight of the beam, about one-half ton, and the hammer, about five tons, was not sufficient to force the beam through, and steam had to be turned on to get it down.

Before the beam started penetrating the rock, the interlocked piling and beam would be pulled tight against the guide wale, so that the cantilever value of the beams in the rock would exert a force toward keeping the wall lined up. The wall would usually spring back out when the hammer was raised, but this was due to the wave in the top line of the sheet piling and not to the irregularity of the beams. Later, when the anchor rods were put on, little difficulty was encountered in straightening the wall against the guide wale.

Few Beams Out of Clips

An examination by a driver after the wall was completed showed that a very small percentage of the beams were out of the clips, except at the points where the beams were bent or where some special splicing of sheet piling was done.

As a whole, the design and installation as finally worked out should be pronounced a decided success. The beams and sheet piling are combined in a manner that gives the maximum strength with the minimum of materials. The experiences encountered would naturally suggest minor changes in details and specifications, as would be the case with any new design; but in nearly every instance possible improvements were considered and introduced before the installation was made, with the result that the structure as completed represents practically the sum total of the experience gained.

Permanent Roads Are Encouraged by Change in Michigan Law

State Reward for Higher Types Is Raised—Superintendents Must Be Road Builders—Maintenance Is Required

By D. A. THOMAS
Michigan State Highway Department

GENERAL amendments to Michigan's highway law, passed by the 1917 legislature in its session just concluded, contain several features of interest from an engineering standpoint and bid fair to accomplish far-reaching results in highway construction and maintenance in the state. Among others, three very important provisions are made by the law in the amended form:

First, the board of county road commissioners is required to serve as an administrative board only, and to employ a superintendent who is a skilled road builder—but who may or may not be an engineer—who shall direct the road-building operations of the county.

Second, each county, good-roads district and township must organize an adequate and efficient system for the continuous maintenance of state-rewarded roads under its charge, and this system must be approved by the state highway commissioner before the county, district or township can receive further state reward.

Third, the reward on bituminous macadam built by the penetration method is increased by 50%; that on bituminous-concrete, cement-concrete and brick is doubled; and, for the last-named types, the width eligible for state reward is increased from 16 to 20 feet.

Value of Skilled Supervision and Constant Maintenance Recognized

The experience in Michigan has been that those counties in which the county road commissioners acted as an administrative board only have produced the best results. The roads that have been under competent and expert supervision have been better constructed, better maintained and cost less than those which have been supervised by newly elected commissioners having little or no knowledge of scientific road building. It is true that among the commissioners and others there have been developed some very competent superintendents who are not engineers, so it was not advisable in framing the bill to exclude them. In the future, however, it is expected that the highway work will largely be in charge of highway engineers.

Michigan, like many other states, is confronted with the problem of how best to secure the proper maintenance of the highways. The state highway department has found it difficult to instill into the minds of the local officials that, not only must the roads be properly constructed, but they must also be competently maintained; that if this is done, unless they are entirely unsuited to the traffic, they can be made to give much more satisfactory service, and the necessity of early resurfacing will be forestalled at a consequent saving in cost which will more than balance the added cost of maintenance. Especially is this true of gravel roads, of which Michigan has more than 3000 miles. These roads, when properly maintained, are able to render effective service in many locations. By requiring local officials to organize an adequate, efficient and continuous system of maintenance, the law is certain to effect a change for the better.

Rewards for Higher Road Types Increased

Under the state-reward system that has been in effect since the state highway department was created in 1905, a reward is paid to all counties or townships on roads constructed according to the specifications of the department. There are seven classes of roads eligible to state reward, ranging from sand-clay construction to concrete and brick-paved roads. The rewards formerly varied from $250 to $1700 per mile, depending upon the class and width. Double reward is paid if the road lies on a trunk-line route. Macadam, including bituminous-surfaced roads, bituminous-concrete, cement-concrete and brick, was entitled to $1000 a mile for a 9-ft. road and 10%, or $100, per mile additional for each added foot of width up to and including 16 feet.

Under the new act, bituminous macadam by the penetration method will receive $1500 a mile reward for a 9-ft. width and, of course, 10% per mile additional for each added foot in width to 16 ft., while bituminous-concrete, cement-concrete and brick will command $2000 a mile for a 9-ft. width and $200 a mile for each added foot in width, thus making possible a maximum reward of $3400 per mile for a 20-ft. road of any of these three types, if on a trunk-line route, as against $3400 heretofore.

Makes State's Share Proportionate to Cost

The increase in reward is an effort to aid further the counties and townships in building roads that will meet the increasing demands of the traffic, and to cause the state to share in the building of the higher-type roads to more nearly the same proportion that it does in the lower-class roads. A recent average of all trunk-line roads shows the share of the cost paid by the state to be 43%. This is due to the large mileage of gravel and macadam roads, on which the state's share of the cost is frequently greater than 50%. On roads such as concrete and brick, however, the cost paid by the state is low, being about 15%. The amendment will do much to lessen the extent to which the counties are forced to stress their finances to build roads commensurate with the traffic, and it will more nearly make the state's share proportionate to the cost on all classes.

[In addition to the above amendments, the Michigan legislature passed a law regulating motor vehicles and their use of the roads, substantially as outlined in *Engineering Record* of Mar. 3, 1917, p. 343.—Editor.]

To Use Anthracite Coal for Roughing Filter Media

Water Softening and Iron Removal Will Be Effected in Municipal Plant Recently Acquired by Lawrence, Kan.

ROUGHING filters in the iron-removal and water-softening plant planned for Lawrence, Kan., are to be filled with anthracite coal and with Joplin chats. A screw dryfeed hydrated-lime apparatus is another feature of the plant, which is part of the $250,000 improvements for which contracts have been let since the city purchased the system. A new pumping station and pipe-line extensions are improvements in addition to the 3,000,000-gal. purification plant.

The water-supply is taken from wells along the Kansas River. It is quite hard and contains a considerable amount of iron. The plan for purifying and softening the water include aëration, the careful mixing by mechanical agitation of lime, plain sedimentation, filtering through a roughing filter, coagulation with mechanical mixing using alum as a coagulant, and filtering through final filters.

Two Roughing Filters

The water is taken from the settling basins and applied to two roughing filters, in which the filtering material consists of 14 in. of graded gravel and 18 in. of finer filtering material, one bed having Joplin chats and the other anthracite coal, similar to that used in the filters at Steelton, Penn. Both materials are to be screened through a sieve having six meshes to the inch, the part passing through the sieve being used. The underdrains for this roughing filter are composed of a false bottom of steel plates with ⅜-in. holes spaced on 6-in. centers.

It is hoped by the use of this roughing filter and the subsequent treating with alum, both coming after a careful mechanical mixing of the lime and six hours of plain sedimentation, to be able to overcome as much as possible the trouble from precipitation of carbonates in the final filter.

The underdrain system of the final filters will be the Wheeler bottom, as it is desired to do away with all metal possible. The filters are to be washed with high-velocity wash, the supply coming from storage tanks.

Black & Veatch, consulting engineers, Kansas City, designed the plant and are supervising its erection.

Three-Section Shield a Feature of Fifth Ave. Tunnel Project

Contractor's Proposal Would Relieve Traffic Congestion by 1½-Mile Triple Arcade of Concrete Blocks

A TRAFFIC-RELIEF subway under Fifth Ave., New York City, extending from about 24th St. to 60th St., proposed by John F. O'Rourke, the New York contractor, would involve certain marked novelties in tunneling procedure. A roof shield of a new kind would be used; it would have three separately movable sections to drive the three independent arcades forming the roof of the tunnel. To furnish a track for the roof shield and give permanent support to the roof arches, post and girder supports would be set in advance in narrow drifts excavated ahead of the shield. Conditions make it desirable that the subway be as shallow, below street surface, as possible. The ground is good, but a length of at least 1000 ft. would encounter rock to full height. Interruption of traffic on the street above, or even the placing of temporary roadway planking or other hindrance to traffic cannot be permitted. Settlement of the street must be minimized to a degree where it will produce no noticeable effect at the street surface and will not cause any damage to the street pipes and other underground structures.

Tunnel Instead of Bridge

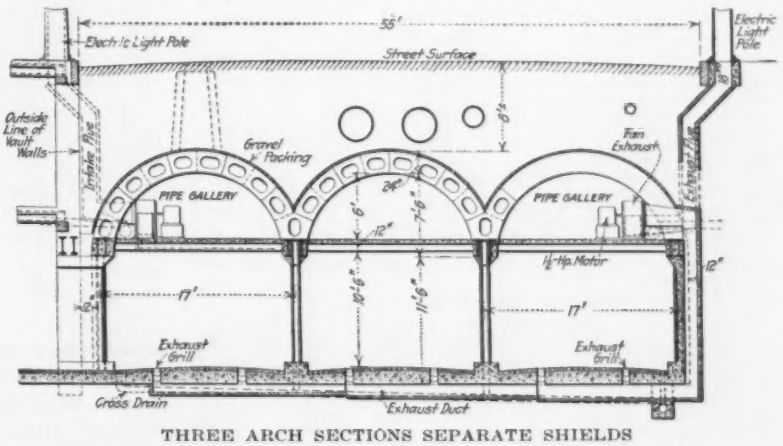
Fifth Ave., the great artery of vehicle traffic between downtown and uptown, New York City, is now congested in very serious manner, chiefly because the traffic stream is interrupted at the transverse arteries, such as 14th, 23rd, 34th and 42d Sts., as well as at numerous other cross-streets carrying considerable transverse traffic. Present tendencies are toward continual rapid increase of the traffic, and the only relief in sight is provision of a thoroughfare free of traffic crossings. A bridge over 42d St. was proposed several years ago to carry Fifth Ave. over what was then the worst point of traffic conflict. The present tunnel project would replace this bridge project and also provide for the other important cross-streets.

These conditions dictate the above-noted limitations on construction methods. Mr. O'Rourke claims that his scheme suits the requirements perfectly.

The cross-section shows the type of structure proposed. The arches would be built of concrete interlocking segment blocks. O'Rourke patent blocks, as described five years ago, are proposed by the designer, but evidently any other type of lining could be used that is capable of being placed directly behind the shield. Gravel packing over the arch is to be shot in by a nozzle passed into a hole in the lining to fill the voids left by the tail of the shield, as was done by the Flinn-O'Rourke Co. in the land sections of the East River tunnels, now near completion.

A single roof shield is contemplated, making the full width of the tunnel a single working face. But the possible difficulties of keeping such a wide and shallow shield absolutely aligned, against the varying face resistances, make it necessary to cut the shield on the two post lines and operate the three arch sections as separate shields, which, however, would be kept always within a few feet of being truly abreast. In other words, the three sections of the shield would be capable of separate advance, within a limited range.

Provision of a firm and rigid track for the roof shield is vital to the avoidance of vertical irregularities and settlements. The permanent arch supports are therefore to be used as track. They comprise steel columns at 20-ft. longitudinal spacing and a girder over them composed of a pair of I-beams set in concrete. To place these tracks, small drifts on the line of the posts would be driven ahead of the shield, and the post and girder system as well as the foundations would be constructed within these drifts.



THREE ARCH SECTIONS SEPARATE SHIELDS

Costs have not yet been estimated, but a total sum of $10,000,000 has been mentioned as sufficient to construct the entire tunnel, about 1½ miles long.

Ventilation Problem Studied

Ventilation is the subject of separate and quite full provision in the design. The arch spaces would be utilized not only to carry pipes and conduits, but also as ventilation chambers for longitudinal distribution of the intake air. Numerous transverse vent ducts drawing from the floor would discharge the subway air through upcasts located in street-lighting lamp posts placed about 100 ft. apart longitudinally of the tunnel. Other lamp-post ducts would be used as inlets.

Growth of Filter Sand at Three Water-Softening Plants

History and Experiments at Columbus, Ohio, Grand Rapids, Mich., and McKeesport, Penn., Given in a Series of Three Articles

Incrustation of filter sand passing water treated with lime for softening purposes largely increases the effective size and reduces the uniformity coefficient. The sand growth and the loss of sand in washing result in an eighth of the original sand ultimately filling the filter tank to its original sand surface level.

Part II—Five Years' Experience at Grand Rapids

By WALTER A. SPERRY

Chemist, Water-Filtration Plant, Grand Rapids, Mich.

THE Grand Rapids water-softening and filtration plant has been in operation since the late fall of 1912, using lime, alum and hypochlorite of calcium to procure a soft, clean, wholesome water.

The sand selected was a local bank sand so near in character that specified by the engineers that the great saving in its cost as compared with that of imported sands offset the fact that the local sand contained too large an amount of the finer sizes. Experiments indicated that this sand could be made acceptable by washing and scraping after it was placed in the beds. The history of this sand is shown by Table I.

TABLE I. CHARACTERISTICS AND HISTORY OF FILTER SAND

	Effective Size, Mm.	Uniformity Coefficient	Per Cent. Acid Soluble
Sand as specified	0.35–0.44	Less than 1.65	5.0
Original sand, as found	0.27	1.61	6.5
After washing and scraping	0.35	1.25	6.5
Sand after use, October, 1913	0.42	1.33	23.0
Sand after use, August, 1914	0.51	1.22	45.2
Sand after use, August, 1915	0.58	1.12	57.6
Sand after use, August, 1916	0.58–0.66	1.0+	68.0

Approximate thickness of sand coating, mm.: August, 1914, 0.040; August, 1915, 0.064; August, 1916, 0.115.

Per cent. volume increase of sand over clean sand: August, 1914, 52.5; August, 1915, 60.9; August, 1916, 72.0.

Specific gravity of sand: As placed in 1912, 2.651; August, 1915, 2.508; August, 1916, 2.424.

Average composition of coating: Calcium carbonate, 80 to 85%; magnesium hydrate and carbonate, 15 to 20%.

Yearly Sieving Tests of Sand, 1913 to 1916

	1913 October	1914 August	1915 August	1916 August	Sieve Sizes, Mm.
Per cent. passing 0.200 mm.	0.0	0.0	0.0	0.00	0.206
Per cent. passing 0.407 mm.	7.4	0.8	0.1	0.00	0.407
Per cent. passing 0.478 mm.	30.3	3.5	0.3	0.00	0.478
Per cent. passing 0.659 mm.	87.9	87.8	76.1	25.20	0.659
Per cent. passing 1.057 mm.	98.0	98.1	98.4	99.20	1.057
Per cent. passing 2.134 mm.	99.9	99.9	99.5	100.00	2.134

TABLE II. GRAND RIVER WATER AND TREATMENT REQUIRED

	Parts per Million	
	River Water	Filtered Water
Alkalinity	202.0	55.0
Incrustants	35.0	37.0
Total hardness	237.0	92.0
Magnesium as Mg	19.6	13.3
Hydrate alkalinity		3.0

Lime per 1,000,000 gal., 1,240 lb. = 8.8 grains per gallon

Alum per 1,000,000 gal., 124 lb. = 0.9 grains per gallon

Hypochlorite per 1,000,000 gal., 5.8 lb. = 0.21 parts per 1,000,000 gal.

The water treated at Grand Rapids is taken from the Grand River. It is of moderate hardness, requiring lime treatment only, to soften it to an average total hardness of 5.5 grains per gallon—a degree of hardness midway between the Great Lakes waters and ordinary cistern water. It differs from many waters, particularly those of the Scioto River at Columbus, Ohio, and the Ohio and Mississippi and Missouri Rivers, in being practically free from all but very small amounts of turbidity and in having a relatively high color. (Average turbidity, 11 parts per million; color, 31.) The average characteristics of the raw and treated water and the amount of treatment required are shown by Table II.

The filter troubles caused by the treatment of this water have taken the form of causing the enlargement of the sand grains, cementing of the sand and gravel, and depositing within the filter of putty-like muds and slimes which, being heavy, tend to roll together in balls, coat heavily the sides of the filter and form columns down through the sand under the wash-water troughs. These coatings are not readily removed by the wash-water pressures available, hence tend to accumulate and must be scraped off and dug out periodically.

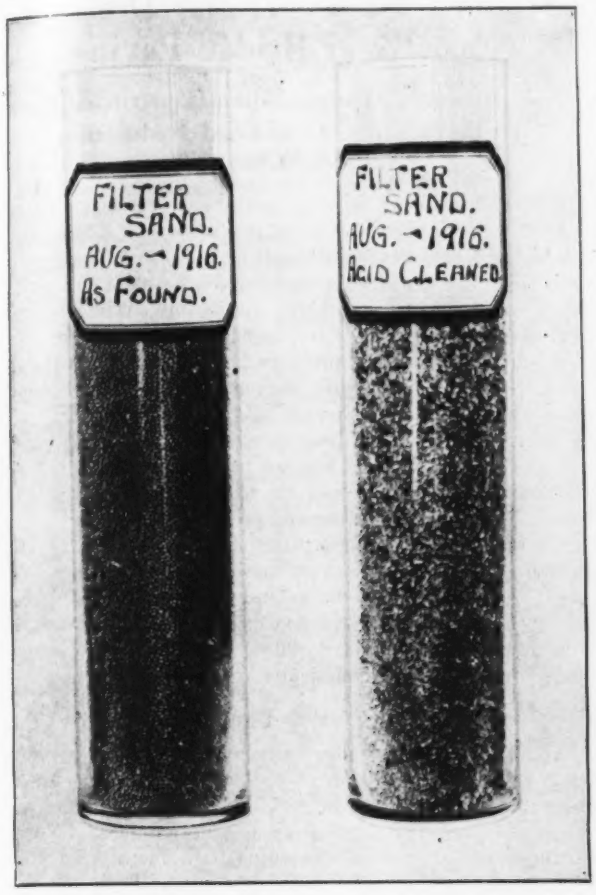
These troubles are brought about by two factors: (1) The tendency of a lime-treated water to "cure" for a time longer than most settling basins can be designed to care for; (2) the presence therein of colloidal forms of magnesium. The tendency of the water to "cure" through the Grand Rapids plant is shown by the following figures, which are the yearly average of several analyses made daily for the year 1916: Average alkalinity in parts per million of river water, 194; water leaving the reaction tanks, 65; leaving settling basins, 58; after passing the filters, 47; water taken from city mains, 47. The drop in alkalinity of 11 parts per million noted in the water just before and just after passing the filters amply explains the present physical condition of the sand.

In 1914 the tendency of the finer grades of gravel to cement became so pronounced that it was thought wise to change the design of the filters by removing the brass screens originally provided between the gravel and the sand, substituting therefor thicker layers of gravel (increased from 8 to 14 in.). Since then, while there has been sufficient tendency of the sand to cement and the upper layers of gravel to pile to make it necessary to overhaul the sand and gravel every winter, this tendency is becoming less and the amount of filter overhauling is reduced, as we have learned how to prepare better the water passing to the filters. Grand Rapids experience seems to indicate:

1. That the principal factor of lime-plant control lies in the percentage of magnesium removed from the raw water treated.

2. That, as the magnesium is reduced, the filters work more economically as to length of runs and amount of wash water required, and that they require less attention and labor as to the scraping and overhauling necessary.

3. That, in addition, the water passing to the mains is better "cured" and therefore more stable, causing less trouble through the distribution system from "after reaction" troubles in the hot-water heating systems and water meters.



FILTER SAND AT GRAND RAPIDS BEFORE AND AFTER WASHING WITH ACID

Note the rounded character of the grains and the very uniform size as compared with the angular grains and variety of size of the original sand

4. That the removal of magnesium seems best accomplished by first applying the lime treatment to reduce the calcium content of the water as low as possible and to convert the magnesium as nearly as possible to the more insoluble hydrate form. The alum treatment should then be applied, the precipitated aluminum acting mechanically to scour out the colloidal magnesium. (The efficiency of this process will be proportional to the amount of alum used.)

5. That the particular kind of sand originally employed for a lime-softening plant does not greatly matter in view of the rapid rate of change of sand characteristics, since the effluents are bacterially and physically of excellent quality and since in such a plant the filters play a different rôle than they do in an alum filter plant proper, acting largely as simple strainers to complete the work of the settling basins.

6. That the principal work in such a plant lies in the treatment given in the reaction tanks and the settling basins.

7. That the principal factor in attaining magnesium reductions is constant attention to the *regularity* of the lime feed and the *amount* and *point of application* of the alum.

[*Next Week: "Eight Years' Experience at McKeesport," by Edward C. Trax.*]

Are Trench Machines Adapted To Laying of Water Mains?

Manufacturers Deny Less Extensive Use Than for Sewers—One Explains Smaller Use in the Past

A QUESTION that has been asked more than once is, "Why are trenching machines used less extensively for water mains than for sewers?" To learn whether the question is justified and to throw light on the subject generally, an appeal for information and opinion was made to three manufacturers of this class of machinery. Two challenge any such assumption as the question indicates. All testify to the use of such machinery by cities and contractors alike. The responses follow:

1. Machine trenching for water mains is at least as common as for sewers, and we should say that the mileage of trenches dug by machinery for water mains and other pipe lines is twice that of machine-dug sewer trenches. As a rule, city water departments are more progressive than sewer departments and are better equipped for handling their work.

2. Sewer trenches are usually deep and are expensive when done by hand labor, while water-pipe trenches are shallower and can be dug more cheaply. Machines suited for water-pipe trenches are cheaper, as they do not have to dig so deep. As a matter of fact, there are probably at least as many pipe-laying contractors owning trenching machines as there are sewer contractors owning machines.

3. Our experience is that, while in the past trench excavators have been used more for sewers than for water and gas mains, this situation has been changing for some time, and the demand for machines to excavate water- and gas-pipe trenches is increasing. A large part of the gas- and water-main trench excavation is done by the operating companies and is not turned over to contractors. This applies to the larger systems. The contractors have been getting mostly the work in small towns, where complete systems are being installed. The trench work required for the small system is usually not a large item.

Machines Not Adapted to City Work

In the case of the large gas- and water-works, continued the third manufacturer, the larger mains are installed in the congested districts of the cities, where trench excavators could not be used. In the outlying districts, where machines may be used, there may be two blocks of mains to be installed in a certain district, or there may be several miles. In any event, the work is not attractive to contractors, because there is not enough of it, and what there is is generally widely scattered.

A large public-service corporation necessarily has a numerous force in its employ at all times, for installing services and meters, maintaining lines and many other duties. When some mains are to be laid, this organization is at hand and the work is turned over to it. Some public-service officials have stated that they could excavate trenches more cheaply by hand than they could by machines, but they had had experience only with hand excavation.

Small town systems are generally installed complete by one contractor. This contractor, as a rule, specializes

in plant construction, gives that part of the work his expert attention and turns the trench excavation over to a foreman who is at his best when in command of a company of laborers.

Formerly Many Poorly Designed Machines

Another thing that heretofore may have been against the machine is the machine itself. Trench-excavator design has made considerable progress in the past several years, and as the demand increases so does the design improve. In the past a great many machines were built and sold that were unsuited to the purpose for which they were intended. It is true that the producers of these machines did not last long, but the machines put out by them certainly discouraged the purchase of this class of equipment.

At the present time there is a distinct change noticeable in the attitude of those extensively engaged in the laying of water and gas mains. This applies not so much to the contractors as to public-utility officials, who are beginning to realize that machines are obtainable which will excavate their trenches more rapidly and at much less expense than is possible by hand work. The shortage of labor has been a great factor in directing attention to the desirability of machine excavation. When one machine will do the work of from 40 to 100 men, and do it more rapidly and at much less expense, and when the hand labor cannot be secured anyway, the contractor begins to think that perhaps there is something in trench excavators and that he had better look into the matter.

Sewer Contractors Have Wider Field

Sewer contractors have a much wider field than those engaged in laying gas and water mains. Practically all sewers are constructed under contract, and the work is done by contractors having adequate equipment, including trench excavators. Water- and gas-main contractors do not have so wide a field, their contracts and profits are not as large, and for these reasons they are generally not so well equipped as the sewer contractors. In addition, a large part of the water- and gas-main construction is done by the owner or operator, and the contractor is barred. Public utilities and municipalities are giving serious consideration to trench excavators at the present time, and there will undoubtedly be a large increase in the use of machinery for excavating water- and gas-main trenches.

New Heavy Freight Car

A hopper car of 85 tons' capacity is being built by the Pennsylvania Railroad Co. to a design for large load capacity and large bulk capacity in combination. The light weight of the car is 60,000 lb. Its load capacity is 170,000 lb., and its volume capacity level with top is 2900 cu.ft. The loaded weight will be 115 tons; and as the trucks are four-wheel trucks, each axle will carry a load of 57,500 lb. under full load. The car is 48 ft. 4 in. long over end sills and 38 ft. 4 in. between truck centers. As the trucks have 5-ft. wheelbase, a pair of such cars coupled together will have four consecutive axles at 5-ft. spacing, each carying over 57,000 lb. load. This approximates the heaviest engine driving-wheel loading used in bridge design. The average weight of the car per lineal foot, however, is a little less than 4800 lb. per lineal foot.

Modern Heavy Traffic Destroys East River Bridge Paving

Floor Systems Adequate When Constructed Have To Be Rebuilt—Dead-Load Reduced in One Case

THE increase in the density and the destructive effect of vehicular traffic to a degree far beyond that anticipated has forced the Department of Plant and Structures, New York City, to reconstruct the floor system and roadway paving of the Brooklyn, Manhattan, Williamsburg and Queensboro Bridges in accordance with the entirely new conceptions of the problem furnished by the experience of the past four years, during which time the motor traffic has increased as much as 300%. The details of certain of these changes were given by Edward A. Byrne, acting chief engineer, in a paper presented Apr. 25 before the Municipal Engineers of the City of New York, from which the following has been extracted:

In 1912 the four East River bridges carried 18,304 vehicles, and in 1916 the number was 35,034. Of the 1912 total, 11,893 were horse drawn and 6411 motor drawn. In 1916, there were 11,584 horse drawn and 23,450 motor drawn, an increase of nearly 300% in motor drawn, while the horse drawn had practically remained the same.

Bad Pavement Hinders Industrial Growth

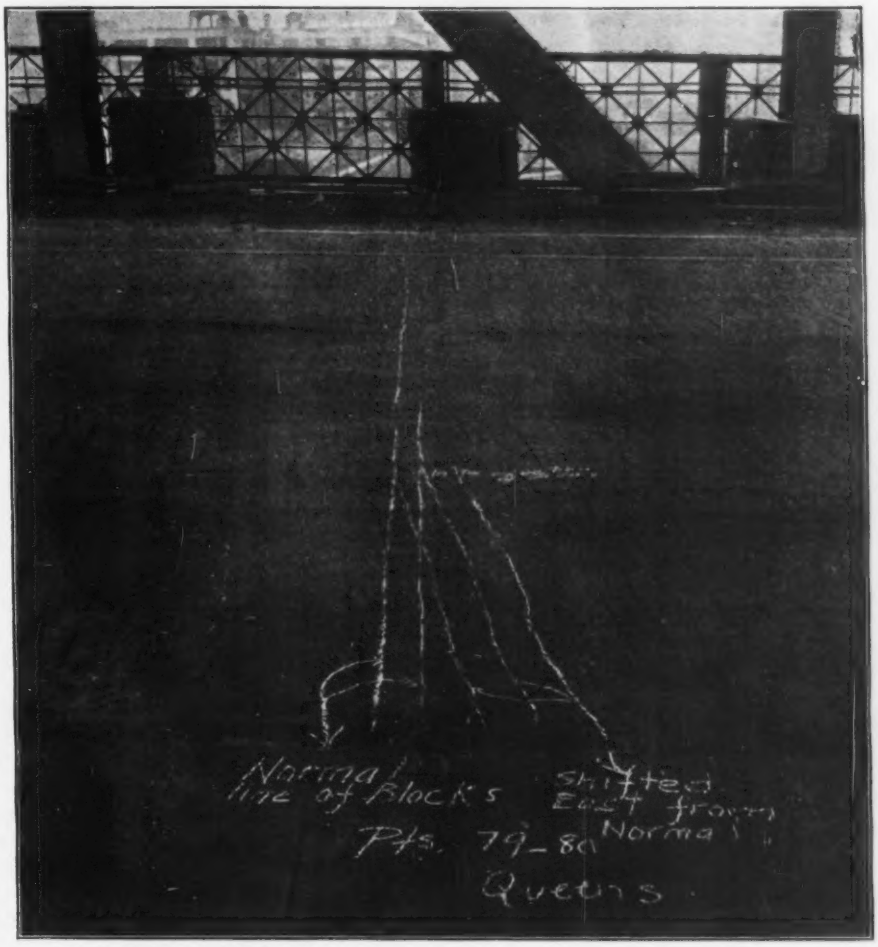
The Queensboro Bridge presented the most serious problem, as the condition of the pavement caused great inconvenience to those who had to use the bridge and no doubt deferred for some time the development of the Borough of Queens in the immediate vicinity of the bridge. The old pavement consists generally of treated yellow-pine blocks 4 in. deep, with asphalt-filled joints, laid on a 1:3:6 concrete foundation. On the main bridge, buckle plates $\frac{3}{8}$ in. thick support the concrete

NAILS, 5½ IN. LONG, DRIVEN THROUGH OAK BEAMS REGISTERED A MAXIMUM BUCKLE-PLATE DEFLECTION OF ⅛ IN.

foundation, and this area, amounting to 34,600 sq.yd., has been a source of constant trouble during the past 4½ years. [Full details of the old, as well as the new and corrective, design have been described in *Engineering Record* of May 2, 1916, p. 670, and Feb. 17, 1917, p. 272.]

To measure the deflection of the buckle plates under traffic, the gage shown in the illustration was set at va-

rious points on the under side of the fillets, being left in position for periods of from three to five days. Deflections up to $\frac{9}{16}$ in. were noted. After the stiffening angles had been installed, similar observations were taken; but no deflections were found in these plates measurable by this gage. The Williamsburg Bridge was opened to vehicular traffic in December, 1903. The two roadways, each 19 ft. 11 in. in width, provide an area of 32,480 sq.yd. of pavement to be maintained. The approaches are grouted Medina (N. Y.) sandstone blocks on a concrete foundation, which have, near the curb, worn as much as 4 in. —their original depth being 6 in. Granite blocks, 5 in. in depth, laid with asphaltic-cement joints, will replace these sandstone blocks. The main bridge is paved with long-leaf yellow-pine blocks, 4 in. in depth, laid at right angles to the center line of the bridge. They rest on 12-in. 20.5-lb. channels, having an average length of 20 ft., laid parallel to the axis of the bridge, with a space of $\frac{1}{2}$ in. between channels. The flanges are turned down and rest directly on 7-in. channels laid transversely on 30-in. centers. The tops of the 12-in. channels were given a coat of hot asphaltic cement, and the blocks were laid on this cement with close joints filled with an asphalt and coal-tar compound.



TRACTION OF MOTOR VEHICLES ON APPROACH GRADE DISPLACES WOOD BLOCKS

In 1909 these channels commenced to show signs of failure. Under the heavily increasing traffic the webs distorted badly, and in many cases this resulted in fracture, as shown in the illustration.

Plank Flooring Allows Use of Shallow Blocks

The plan proposed by Mr. Byrne consists of laying on the channel floor long-leaf yellow-pine plank dressed on sides and edges to a uniform size of $2\frac{1}{4} \times 9\frac{3}{4}$ in. The plank, treated by brush method, extends from curb to curb in one length and is bolted to the channels by two $\frac{1}{2}$-in. bolts at every alternate channel. The top surface of the plank was coated with paving pitch, and the roadway was divided into 20-ft. sections by transverse angles. In these spaces were laid creosoted wood blocks $2\frac{1}{2}$ in. deep, cut from 2 x 6-in. yellow-pine plank, and purchased under the same specifications as those used on the Queensboro Bridge.

There are about 1500 sq.yd. of these blocks in place, and this is the first place where blocks as shallow as this have been used. They are standing up well under the traffic, and in the opinion of Mr. Bryne, this proves that if the wood underdeck is securely bolted to the supporting structure, the shallow paving block can be safely used. Compared with a 3-in. block, its use means a saving in original cost of block of about 17%.

Spruce Planking Lasts Only Six Months

The Brooklyn Bridge has two roadways, each 16 ft. 9 in. in width, and a trolley track is laid on each of them near the inner curb. Considering the width of roadway, this means the passing of but a single line of vehicles at the outer curb. The pavement of the main bridge consists of $2\frac{1}{2}$ x 10-in. spruce planks laid transversely on $3\frac{1}{2}$ in. to 5-in. creosoted yellow-pine timber, laid longitudinally on steel crossbeams. The planking on the upgrade averages four months' wear, that on the downgrade averages six months, and that on the part near the center, which is nearly level, averages eight months. This means the renewal of planking twice during the year—a very costly item of expense.

Several experiments were made, and it was finally decided that creosoted yellow-pine blocks $2\frac{1}{4}$ in. in depth, cut from 2 x 6-in. plank and laid on an untreated yellow-pine underdeck, would meet all requirements. There are now 150 lin.ft. of this pavement in place on the north roadway of the bridge.

The plan further provides for the replacement, by a grooved girder rail, of the T-section trolley rail, which is

not suitable for use in a roadway of this type. The T-rail affords very poor facility for the turning in and out of vehicular traffic from the track area to the roadway area since it is laid 1¼ in. above the grade of the roadway; and it is expensive to maintain on account of its inadequate supports.

Added Dead-Load of New Pavement Balanced by Smoother Surface

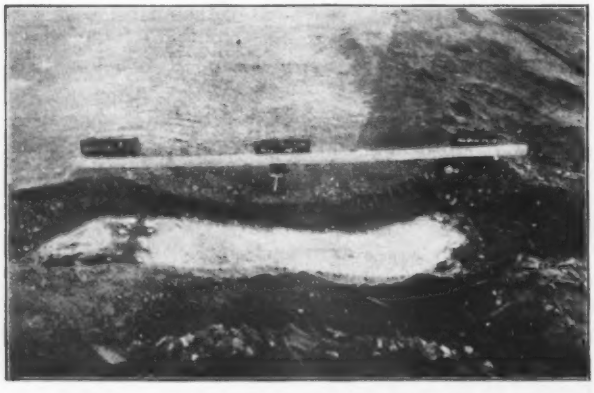
The new design of roadway floor will add 100 lb. per lin.ft. of bridge for both roadways, two-thirds of which will be carried by the outer cables and one-third by the inner cables. The present dead-load per linear foot of bridge is 800 lb., but the increase in dead-load is more than offset by the fact that the present rough spruce-plank will be replaced by the smooth wood-block pavement.

The pavement of the approaches consists of tar and gravel filled granite blocks, 8 in. deep, on a 2-in. sand cushion, supported by a concrete foundation. These were replaced by blocks 5 in. in depth laid on a 1-in. sand cushion with joints grouted. The foundation of the old block was in good condition and was not removed, but an additional layer of concrete was laid on top of the old foundation, so that the new block would be at the old grade.

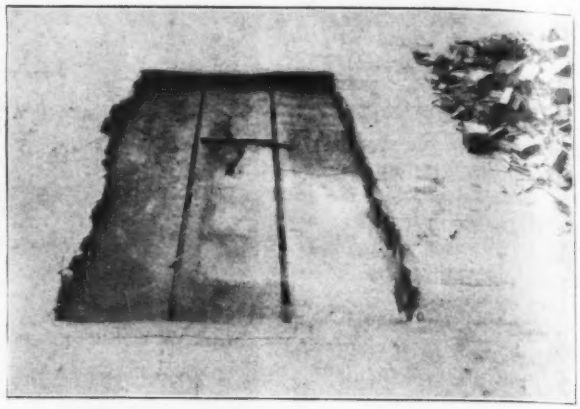
The Manhattan Bridge was opened to traffic in December, 1909, and to date only slight pavement repairs have been necessary. The main bridge and steel approaches are 4-in. creosoted wood blocks on a creosoted yellow-pine underdeck, granite block on concrete being used on the masonry approaches.

Suggests Standard Specifications

In the design of new bridges, Mr. Byrne is of the opinion that, when weight is the factor, wood block on a timber floor is the most satisfactory pavement that can be used; but if conditions permit the use of a heavier material, granite block is to be preferred. Where the design calls for a wood-block pavement on a timber floor, the following is suggested as a specification that will give satisfactory results: The underdeck shall be of untreated long-leaf yellow-pine timber of merchantable inspection dressed on sides and edges to a uniform size, laid with close joints and fastened to the supporting stringers by means of screw bolts ⅝ in. in diameter, so spaced that every course of planking shall be bolted at each supporting stringer by two bolts.



DEFLECTING BUCKLE PLATE FORCED LEAN CONCRETE BASE TOWARD MORE RIGID STRINGERS



CONDITION SHOWN IN PRECEDING COLUMN COMPLETELY REMEDIED BY 2½-INCH CROSS-PLANKING

The heads of bolts shall finish flush with top of timber, have flat wrought-iron washers under heads, and at the end have wrought-iron clips shaped to the form of the top flange of the supporting stringer. Locknuts shall be provided for each bolt.

After bolts have been fastened, the countersunk bolt holes shall be flushed with cement mortar, affording an even surface on which to lay the wood-block pavement.

The wood blocks are to be not over 3 in. in depth and cut from plank not over 3 in. thick and 8 in. wide. The blocks are to be laid with close joints at right angles to the center line of the bridge, with each longitudinal joint broken by a lap not greater than one-half of the length of the block. A fine sand, as free as possible from moisture, should be thoroughly brushed into the joints. On top of the pavement a layer of sand about ½ in. depth should be spread before permitting traffic.

War Prices for Chemicals Raise Water-Treatment Costs

Plant at Nashville, Tenn., Shows Increased Operating Expenses for Coagulation and Chlorination

HOW war prices for water-purification chemicals have hit scores of cities is illustrated by the experience of Nashville, Tenn., where Cumberland River water is cleaned and disinfected by coagulation, sedimentation and disinfection in a two-basin reservoir.

The 1915 contract for sulphate of alumina was made at 97c. per 100 lb., 1,200,000 lb. per year being required. The 1916 contract, still in force, is $1.10 plus freight. Hypochlorite, of which 76,000 lb. per year is required, cost $1.85 per 100 lb. in 1915. The city has been unable to make a new contract, but has been obliged to buy at market prices, the cost being from $4.50 to $5. Moreover, the railroad situation has lengthened the time required for shipment from a few days to a month, which is sufficient to cause part of the shipment to spoil.

Under the higher chemical prices the cost of treatment is now estimated at $5.90 per 1,000,000 gal. treated, against $3.40 before. In addition to the chemicals the only items to be charged against water treatment are interest and depreciation on the solution tanks, pumps,

motors and agitators, all of which are valued at about $1000; part of the time of the reservoir foreman, three watchman and a laborer; and the annual removal of sediment from the reservoir.

Sulphate of alumina is applied at a minimum rate of 1 grain per gallon, or 142.8 lb. per 1,000,000, gal. For the larger part of the year the turbidity is low; but during two months it is as high as 3200, and the coagulant rate is doubled. The turbidity reading is taken daily by one of the watchmen who has been trained by the superintendent to do this accurately.

The chlorine dosage is at the maximum rate of 0.1 grain per gallon, or 14.4 lb. per 1,000,000 gal., and a minimum of 0.055 grain. It is governed by the results of the daily bacterial counts by the city bacteriologist. The count is kept down to 35 or 40 colonies, with no acid colonies or B. coli. Under usual conditions 8 lb. of hypochlorite is sufficient, but for short periods the maximum is required.

About 6000 cu.yd. of sediment are deposited annually, making an average of $2.66 per cu.yd. of precipitated matter as the cost of treatment. The annual pumpage is about 4,800,000,000 gal., ranging from 10,000,000 to 16,000,000 and averaging 13,000,000 gal. a day, in round numbers. George Reyer is superintendent of water-works.

Stone Bridges in French Battle Area Rapidly Rebuilt

Masonry Arches Destroyed by Army Replaced by Concrete Arches Without Use of Falsework

THE exigencies of battle in the north of France have required the rapid and stable reconstruction of a number of masonry arch bridges that had been more or less completely destroyed by the German or by the Allied forces for military reasons. These bridges are generally in an area where timber and cut stone are scarce, and their reconstruction must be done rapidly without the aid of the needed quota of skilled artisans. To meet these conditions, concrete arches placed without the use of falsework have been successfully employed in a number of cases.

Cement, of course, can more readily be brought forward than any other structural material, and sand and gravel are local products, so that concrete, which can be made by unskilled labor, is doubly effective for such work. A novel feature of the reconstruction, however, is the use of old iron and a minimum of timber for arch centers, which can be readily erected, thus saving time and labor. As a rule, these centers are of old steel rails, curved to an arch immediately below the main arch rib and carrying the concrete of that rib on a supplementary thin concrete arch cast on a timber frame supported from the rail ribs.

The reconstruction of one such bridge according to this method is described in *Le Genie Civil* for Apr. 7, 1917. This bridge is one across the Meurthe River and was rebuilt by the railway company that operated the two-track line crossing it. The bridge, shown in Fig. 1, originally comprised three 60-ft. masonry arches, of rather low rise. Two of these were completely destroyed, as shown in the drawing.

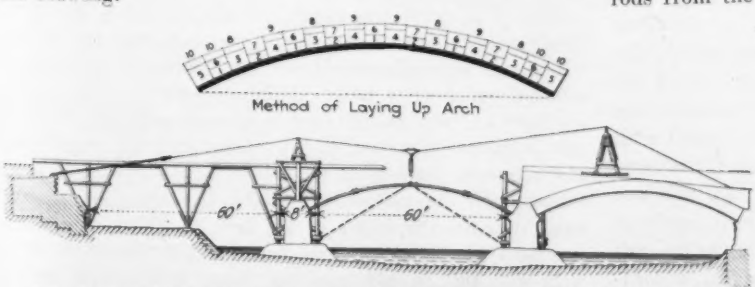


FIG. 1. RESTORING ARCHES IN DESTROYED STONE BRIDGES IN BATTLE AREA OF FRANCE

The first operation was to build the light timber framework carrying the footway and erect thereon the towers for a construction cableway. From this cableway a series of centering ribs made up of old steel rails was placed. These rails, which were found in the neighborhood, weighed 60 lb. to the yard. They were cold bent to the proper curve, in two sections, as shown, and spaced 20 in. c. to c. clear across the arch. At the abutment they were bolted to a bedplate that was held by a hook bolt driven into the masonry. These curved rails were used as the basis of a thin concrete arch that in itself served as the center for the main arch. This procedure was adopted rather than placing the main arch immediately upon falsework hung from the steel ribs themselves, because the rails were not sufficiently strong to act as centers.

The details of the centering are shown in Fig. 2. It consisted merely of timber joists and a floor hung by steel

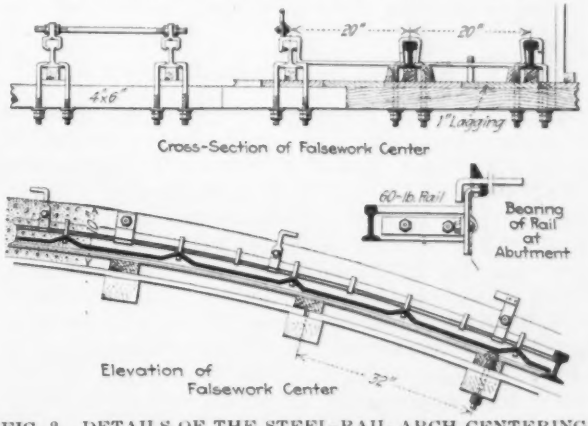


FIG. 2. DETAILS OF THE STEEL-RAIL ARCH CENTERING USED ON MEURTHE RIVER BRIDGE

of the arch. This concreting was done in two parts, a 1:2:4 concrete was placed for its uniform thickness of 10 in. from abutment to abutment, and for the full width rods from the old rails. On this a concrete arch rib of crown section and two abutment sections being first placed and the intermediate sections last. The whole concreting of this shallow section could be done in one morning. Ten days was allowed for this concrete to set. Meanwhile the top of the rib was laid off in 19 voussoirs, and a vertical dividing wall was erected across the arch at each voussoir division line. This dividing wall was made of a wire mesh, large enough to hold the aggre-

gate, fastened to ¾-in. and ⅝-in. vertical rods tied in at the bottom to hook bolts that had been left emerging from the centering concrete. These frameworks having been placed during the 10 days allowed for the setting of the centers, concreting was carried on across the arch rib in the voussoirs so laid out, placing them across the bridge so as to impose the least eccentric loading on the centering arch. The progress of voussoir deposition is shown in Fig. 1. All this concreting for one 6-ft. arch could be done in two 10-hour days.

After the main arch rib has achieved a sufficient set, the centering arch can be removed, although this is not necessary. Meanwhile, the superstructure of the arch can be erected in a continuous process following the construction of the main arch rib, and the roadway put into service in a minimum of time.

Old Forms Reused as Base of Concrete-Roof Installation

Condensation Under Roof Prevented by Covering of Tar Paper Laid on Old Forms Used in Construction

AN ECONOMICAL method of reducing heat transfer through concrete roofs, which also served as a preventive of the condensation common to such roofs, was recently applied to a large reinforced-concrete cotton mill by Charles H. Bigelow, chief mechanical engineer of the Millville Manufacturing Co., Millville, N. J., and described by him in a paper read before the American Society of Cotton Manufacturers.

Drippings from Condensation

In a number of reinforced-concrete cotton mills the moist warm air inside and the poor conduction through the concrete roof have resulted in considerable condensation on the inside of the roof and the dropping of water on goods to their damage. In some cases, notably at the Naumkeag weave shed at Salem, Mass., the entire concrete roof has been covered on the outside with cork board, over which has been laid a five-ply tar and gravel roof. This has proved very successful; but when the Millville building was put up, the price of cork had increased so that the method was practically prohibitive. A number of other schemes were suggested, such as the use of California cedar and of hair felt. The first was too expensive, and the second was rejected because it was open to the objection of being soft and liable to be broken by anyone walking on it, as well as to the fact that it would absorb water leaking through it, become wet and soggy and thus lose its insulating value.

It then occurred to Mr. Bigelow to use the old form lumber that had been employed in the concrete of the building. This was laid on screeds placed on top of the concrete roof, leaving about 1-in. air space between the roof and the planks. The boards were then covered with five-ply barrett specification tar-and-gravel roof, the same as was designed to go on the concrete slab. To this was added a single thickness of three-ply Cabot Quilt, made up of heavy paper and field grass, which increases the insulating condition about 20%, although the big saving, according to Mr. Bigelow, is in the boards and air space.

In answer to the query whether the wood might dry-rot, Mr. Bigelow said that he did not see that that would cause any serious trouble, as possible rotting would be confined between the concrete slab and the tar roofing, and any dry-rot would only increase the air spaces and insulating properties. However, the boards are to be treated with wood preservative to protect them against rot.

Calculations of the saving in heating the building due to this installation show a saving of about 15 to 22% on the money invested in the installation. The estimated cost of the protection is about 8c. per sq.ft., making a total estimated expense for the 55,000 sq.ft. of roof of a little over $4000. About $3000 worth of heating equipment is saved, so that the investment from an economical standpoint is very attractive, to say nothing of the saving in condensation loss.

Water-Works Intake Guarded by Ice Fender

V-Type Barrier of Braced Piles and Sheeting at Detroit Built Upstream of Crib To Prevent Clogging

ICE troubles at the Detroit water-works intake crib in the winter of 1915 became so serious that the clogging of the ports to the 10-ft. tunnel lowered the water level in the reservoir by 4 ft., or reduced its capacity by about 30% in less than an hour. To prevent such trouble, the construction of an ice fender was decided upon.

On account of severe conditions (the crib is 3000 ft. out from shore at the upper end of the Detroit River, which has a 4-mile current, and is exposed to the ice floes and waves of Lake St. Clair), a V-type fender was employed.

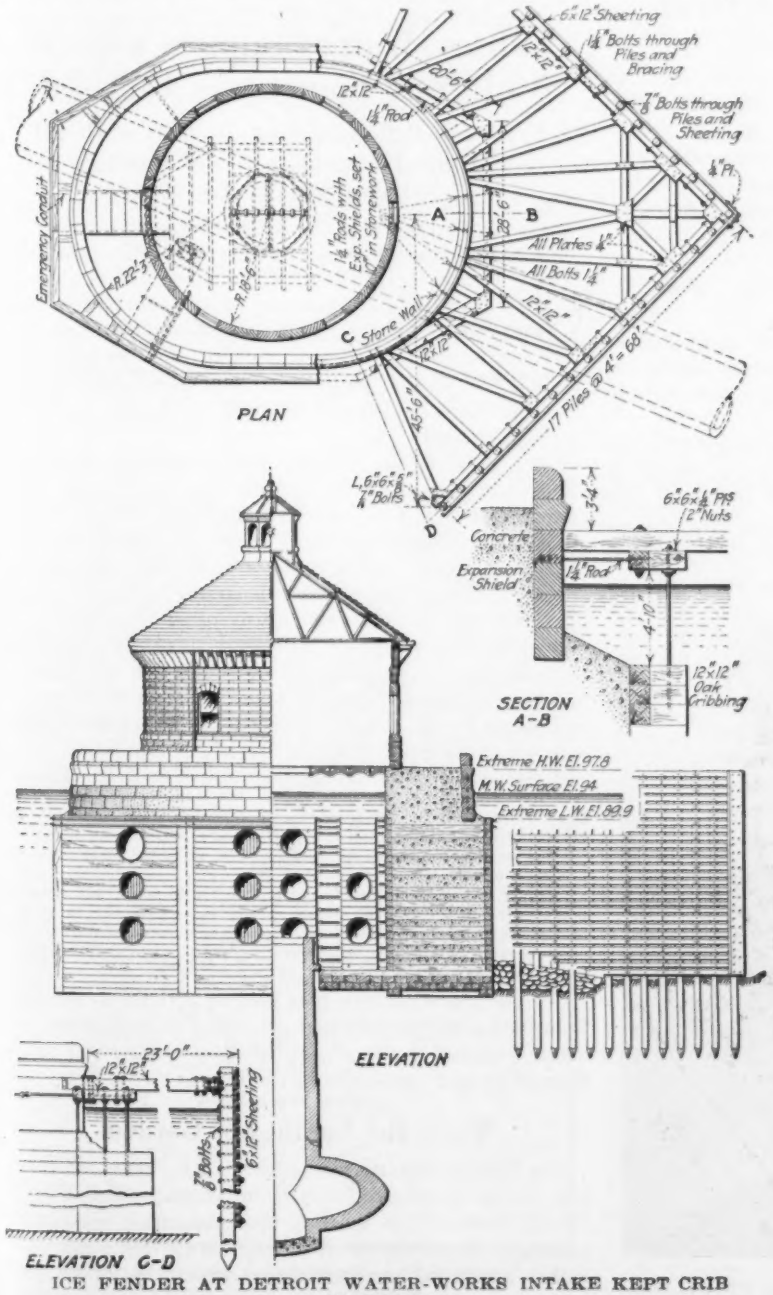
The nose of the fender is 39 ft. directly upstream from the crib, and the wings diverge at 90°. Their downstream ends are 25 ft. from the nearest point of the crib and 4 ft. below its upstream edge. Fifty-foot piles were driven on 4-ft. centers to a penetration of about 15 ft. Greater penetration was deemed unwise because of possible disturbance of the intake tunnel, which is extended 75 ft. above the crib. The piles are sheeted up on the outside from the bottom of the river to the high-water line with 6 x 12-in. yellow-pine timbers bolted through the piling. These timbers are spaced 1 in. apart for the top eight rows and 3 in. apart below.

Bolted along the inside of the piles, 2 ft. above the water line, is a 12 x 12-in. stringer that carries the outer ends of the braces. All braces are of 12 x 12-in. long-leaf pine and are designed for compression only, the different members being held at their outer ends by a single bolt, sufficient to carry the weight of the timber to the ¼-in. steel gusset plates. At the inner ends the braces are supported some distance from the stonework of the crib against which they butt. This support is a 12 x 12-in. stringer carried around the upstream edge of the crib and supported vertically by means of 2-in. rods from the old crib timbers 4 ft. below water. It is secured horizontally by numerous rods with expansion shields sunk into the stonework of the crib, as shown in the accompanying sketch, and is further held by 1¼-in. rods with shackles in old mooring rings in the crib stonework.

It was not considered practicable to build a rigid fender; certainty of some movement of all the members was recognized, and some play at the inner butts of the braces. The amount of the movement was only conjecture, however; and if the motion proves to be excessive, the wings of the fender will be tied into the stone cribwork by heavy rods.

The contract for the work was let to the Candler Dock and Dredge Co., Detroit, for the sum of $16,077.

During the winter just closed, there was no ice trouble whatever at the intake crib. During part of February pumping reached the rate of 225 million gallons per day, which figure was largely in excess of previous records. The fender stood satisfactorily against heavy ice floes.



ICE FENDER AT DETROIT WATER-WORKS INTAKE KEPT CRIB PORTS CLEAR

Sewage-Disposal Requirements in Columbus Getting More Rigid

City Takes Whole River for Water-Supply, Leaving Little for Dilution—Operation of Imhoff Tanks Satisfactory

BECAUSE of the diminished flow of the Scioto River the sewage-disposal problem of Columbus, Ohio, is getting more and more acute, according to the latest annual report of Jerry O'Shaughnessy, superintendent of water and sewage disposal. During the summer months the city takes the entire flow of the river for its water-supply, leaving only the Olentangy, reaching at times a minimum of 5,000,000 gal. per day, whereas the normal discharge of the sewage is nearly 20,000,000 gal. Results of inspections of the river above the outfall indicate that there is entirely too much pollution either from industrial wastes or from clogged intercepting connectors, or both. From the treatment point of view it is vital that the river should be kept substantially unpolluted before it reaches the treatment works, so that the effluent can have the full advantage of the slight dilution that it provides, particularly during low stages. For these reasons it is necessary to maintain treatment service at all times of the year excepting when dilution and stream velocity make it safe to discharge untreated sewage into them.

Imhoff Tank Operation

According to the provision of the original plan of reconstruction, one-half of the old tanks were to be remodeled during the first building season, leaving the other half free for treatment. Then during the second season the new tanks were to be available while the work was completed. In operating the new Imhoff tanks it was necessary to use them at double their rated capacity; and also it was impossible to reverse the direction of flow, because of the fact that the influent channel was used as a sand-catcher in order to keep the sand and street detritus out of the Imhoff tanks. These tanks, even at the high rate, gave good clarification until they began to foam vigorously. The foaming did not, apparently, reduce their efficiency during its early stages, but after the foaming had continued for some time the clarification was impaired. It was impossible to try any operating "stunts" that might prevent foaming. The 10 acres of sprinkling filters were equipped with new modified Columbus nozzles. It is stated that it is

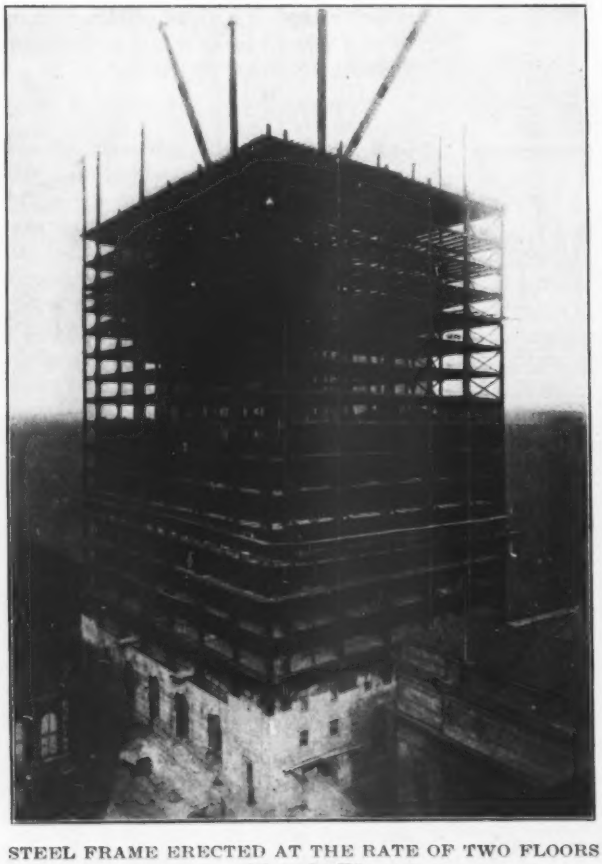
easy to keep these nozzles in good spraying condition without much labor. There was practically a total absence of pooling on the sprinkling filters during the entire season. Nitrification was very good after it had become well established, which required about 1½ months. The results for the season indicate that a satisfactory sprinkling filter effluent cannot be secured unless the effluent is extremely well nitrified, and this also seems to be necessary before an effluent can be produced that will not become offensive after a three days' incubation at 37° Centigrade.

Fast Construction Pace Set in Erecting Steel-Frame Hotel

The Statler, at St. Louis, Progressed at the Rate of Two Complete Floors in 4½ Days

STEEL erection at the rate of two complete floors for each 4½ days marked the construction of the steel frame for the Statler Hotel at St. Louis, Mo. The building is 150 x 130 ft., and 20 stories high. The total amount of steel was 4500 tons, of which 700 tons were in the basement. Time was an important element in the construction of the building, and the steelwork was done on a 10-hour shift until it was apparent that this work would be completed ahead of the schedule.

Work was commenced in January, and by the first week in March the roof was being placed. Above the basement the steel erection progressed at an average rate of two floors for every 4½ days. The work was done by means of two 12-ton guyed derricks, each having a 100-ft. steel mast and 90-ft. steel boom. These were specially designed for the work and were built for the erection contractors by the Minneapolis Steel and Machinery Co. Each derrick was served by a 200-hp. electric hoist built by the Thomas Elevator Co., of Chicago. The accompanying view shows the general type of framing, with the two derricks standing on the eighteenth floor.



STEEL FRAME ERECTED AT THE RATE OF TWO FLOORS IN 4½ DAYS

This work was done by the International Steel Erection Co., of Waukesha, Wis. The Westlake Construction Co., of St. Louis, has the general contract. The deep foundation work was described in *Engineering News*, Mar. 29. The architects are George B. Post & Sons, of New York, and Mauran, Russell & Crowell, of St. Louis.

Kansas Water-Supplies with B. Coli May Sometimes Be Used

Tests for Differentiating B. Coli of Fecal from Those of Soil and Grain Origin Serve as Guide

By C. A. HASKINS

Engineer, Division Water and Sewage, Kansas State Board of Health, Lawrence, Kan.

ORDINARILY, the presence of the colon bacillus in water in certain dilutions is sufficient to cause that water to be condemned for drinking and domestic purposes. This is true under the Government standard for drinking water which was adopted by the Treasury Department in 1914.

On account of the fact that many times in our water-supplies in Kansas the colon organism was found in dilutions of 10 cc., 1 cc. and sometimes even less, where a sanitary inspection failed to show that there was any particular reason for the appearance of the organism, an investigation was made by the laboratory of the Division of Water and Sewage and also by other laboratories, to determine, if possible, the difference in origin of various types of the colon bacillus. It was found that it is feasible to separate the soil organisms and those of fecal origin, and accordingly a recommendation was made to and adopted by the State Board of Health, as follows:

> It is recommended that the State Board of Health authorize the approval of water-supplies for domestic consumption that contain the so-called soil and grain coli and none of the so-called fecal type, with the following restrictions:
>
> The sanitary inspection shall show no probable source of contamination.
>
> Where a water-supply is satisfactorily located, yet returns positive results for organisms of the B. coli group, a series of analyses will be made and the water passed for domestic consumption where all confirmatory results show that these organisms are all of the soil type.

We are of the opinion that holding strictly to this differentiation will be fair and just until there is more evidence collected to the effect that fecal strains will adapt themselves and propagate in the soil.

Water for Vacant-Lot Gardens

The town-gardening idea would fail in Denver if water had to be purchased at current rates. The Denver Union Water Co. is meeting the proposition more than halfway. Not only is it giving away the water, but it has appointed an agricultural expert to advise with amateur husbandmen.

Power Carried 548 Miles from Hydro-Electric Station Working on Both 1247- and 1777-Foot Heads

Rush Creek Plant Draws Water from Two Reservoirs—Tractors Carried Material 56 Miles, and Cable Railways Lifted It to Dam Sites

GEM and Agnew Lakes, lying in the upper levels of the Sierra Nevada Range, in Mono County, California, have just been developed as reservoirs to supply the latest addition to the Nevada-California Power Co.'s 1190-mile system—the Rush Creek station of the Pacific Power Corporation. One of the most interesting features of this development is the utilization of two high heads, differing by 530 ft., in the same power house and on the same wheel. The difficulties of construction themselves form an interesting chapter upon the work.

Company Has Longest Power Line

The transmission lines of the Nevada-California Power Co. system form the longest chain yet projected, being about 666 miles from north to south end. However, power is not transmitted all this distance, for the maximum stretch from the most northerly generating station (at Lundy, see accompanying sketch map) to the southerly end, at Calexico in the Imperial Valley district, is about 481 miles. An extension to Yuma, Ariz., being built, will make this 544 miles. The new plant at Rush Creek feeds into the system south of Lundy, but with its 8½-mile tie line is about 548 miles from Yuma.

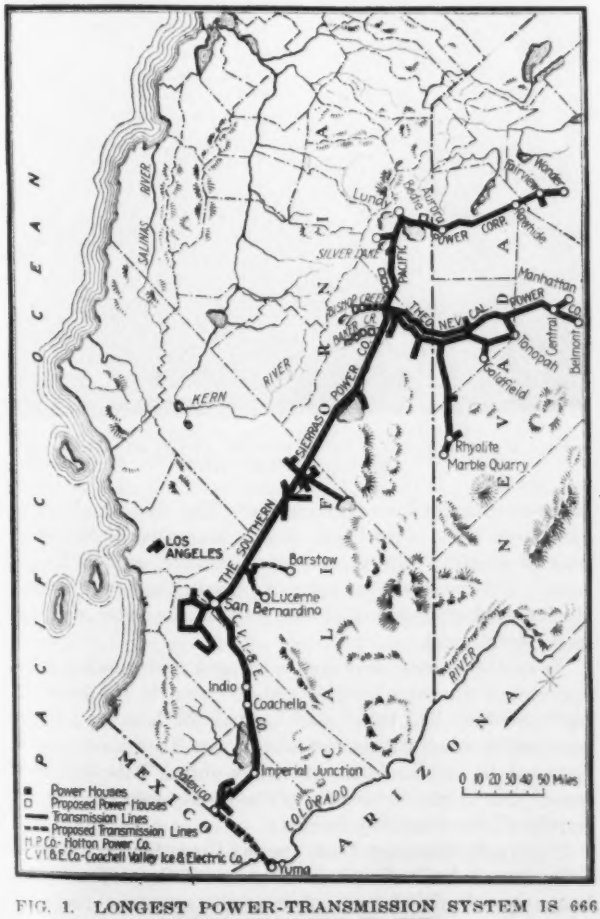


FIG. 1. LONGEST POWER-TRANSMISSION SYSTEM IS 666 MILES FROM END TO END

From Lundy, a 122-mile line runs to the mining camps of Bodie, Aurora, Rawhide, Wonder, etc. From the Bishop terminal, lines stretch out for about 140 miles to Rhyolite, Goldfield, Tonopah, Manhattan, etc. The total length of transmission lines is about 1190 miles. The voltage so far has been held down to 55,000, but it is intended to raise it to 110,000. The northerly extension and tie lines mentioned above are wood-pole construction; the backbone lines are on steel towers.

Multiple-Arch Dams at Reservoirs

Gem Lake and Agnew Lake are adjoining basins with reservoir surface elevations of 9050 and 8500 ft. respectively. Gem Lake has a drainage area of 22 square miles, and Agnew Lake adds 1.7 square miles. Gem reservoir has 17,000 acre-feet capacity and Agnew 400.

Gem dam is a Jorgensen multiple-arch reinforced-concrete structure, 700 ft. along the crest, with sixteen 40-ft. arches and two fractional end arches. The Agnew dam is similar, but only 280 ft. on the crest, with seven arches. (These structures were described in *Engineering News*, Dec. 21, 1916.)

This type of dam was used, as a gravity section was out of the question, with cement costing $7.50 per bbl., due to the difficult haul. As there was no soil available, the only other type considered was a timber-faced rock-fill, but the rock here was shaly, broke in long slivers, shot too fine and was difficult to quarry.

Power House and Pipe Lines

The power station is at Silver Lake, with a tailrace level 1777 ft. below the upper (Gem) reservoir level. A 48-in. riveted steel line 4584 ft. long, dropping 510 ft. and having a wall thickness of from $\frac{3}{16}$ to $\frac{9}{16}$ in., runs to a connection for the pipe from Agnew Lake. At this point the 48-in. line ends in a Y and is to run on as two 30-in. lap-welded lines, with a valved 30-in. cross-over connection. Only one 30-in. pipe is installed at present, together with half the cross-over, including the valve. There is connected to this first 30-in. line, above the cross-over, a similar line with valve, coming over from Agnew Lake. This last line is 607 ft. long and has a fall of 14 ft. The 30-in. line thus constituted from Agnew reservoir to the station is 4836 ft. long and has a fall of 1220 ft. The second 30-in. line is now being fabricated and will be laid on 5-ft. centers from the first line. Close to the power house the lines are reduced to 28-in. diameter. The wall thickness varies from $\frac{1}{4}$ to $\frac{13}{32}$ inch.

At changes of grade are anchor piers encircling the pipe; at these points clamps grip the pipe just below a

FIG. 2. GENERATOR VOLTAGE IS STEPPED UP FOR LINE BY OUTDOOR TYPE TRANSFORMERS

joint and bear on vertical rails in the pier, the joint being left exposed for calking.

The first 30-in. line terminates in a 7½-in. nozzle on an 8000-hp. impulse wheel, which is designed for good efficiency under either reservoir supply—at 1247- and 1777-ft. gross head or 1180- and 1690-ft. net. To the wheel is direct-connected a 500-kw. 2300-volt 60-cycle three-phase generator. Another 5000-kw. unit will be connected to the second 30-in. line, being designed for the higher head. In the station also are two wheel-driven 60-kw. exciter units, one with a motor attached. The transformer house is separate from the generating station, and outdoor-type apparatus is used.

Transportation Made Cement Cost $7.50 per Barrel

It was noted that cement cost $7.50 per bbl. delivered. Difficult transportation was responsible. The powerhouse site was 56 miles from Benton station on the Southern Pacific narrow-gage line. There was a sandy wagon road through desert country, and caterpillar tractors were considered to be the only possible solution of the haulage problem. Even then, practically the whole road had to be worked on to get a footing. The 9-ft. tread of the tractors made necessary considerable steep side-hill excavation. Six 75-hp. Best tractors were used, making 26 trips per month during 1916, with an average load of 20 tons. In all, 5000 tons of material were thus transported.

At Silver Lake, the end of the road, a 400 x 120-ft. yard was filled in over a swamp, and here are located the machine shop, blacksmith shop, offices and warehouses. From one side of the warehouse, a narrow-gage tramway leads by devious pitches and windings 4800 ft. to the hoisthouse at Agnew. The first incline rises 1290 ft.; the maximum grade is 67%. It was necessary to use curves of short radii, the minimum being about 75 ft. One feature is the intersection of a 37% grade from below with a 60% grade from above on a 32° curve. Calculation and experiment showed that the cable-drawn car could be operated over the track by the use of a large sheave properly placed and provided with guides. Accordingly, a 3½-ft. sheave was mounted on an inclined axle 3 ft. from the inner rail of the curve. While the car is below, the cable runs around the sheave, being seated upon it by converging iron-shod guides. The hoist is near the Agnew dam site and is driven by a 100-hp. variable-speed electric motor. The car usually carries four tons, sometimes five. Running light, it is hoisted at about 400 ft. per min.; loaded, at 300 ft. per min. The car has 3-in. vertical play in the boxes so that the upward component of the pull of the cable will not cause derailment.

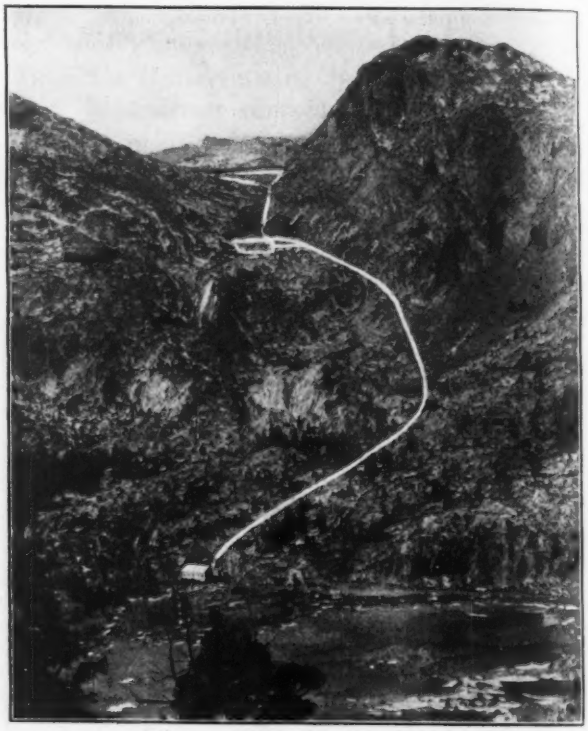


FIG. 4. STEEL PIPE LINE WINDS FROM STATION UP TO TWO RESERVOIRS

FIG. 3. EXPENSIVE TRANSPORTATION DICTATED MULTIPLE-ARCH REINFORCED DAMS

Near the Agnew terminal a second and smaller hoist operates a tramway leading 400 ft. down to the lake. A half-mile trip had to be made across the lake on a barge carrying a windlass around which was drummed a cable fastened to the landings at either end. This was slow travel, but it was necessary to make only two trips a day to take all the tramway freight.

The upper tramway, from the far barge landing to Gem Lake dam, is built almost entirely on trestles. The trestle bents were built of logs cut near the site, and the rails were laid on stringers made of heavy rough-hewn logs.

Thus the use of cross-ties was eliminated, as the caps of each bent sufficed to maintain the spacing of the heavy stringers and prevent spreading of the rails.

The incline from Agnew to Gem carried the rock for Gem dam concrete. This rock was obtained from a quarry in a granite slide close to the lake, about 600 ft. from the tramway. A loading bin and chute were built at the tramway, and an aërial cableway was used to carry the stone from the quarry to the bin.

The dams were built by the Duncanson-Harrelson Co., of San Francisco. The pipe-line contracts were placed with the M. W. Kellogg Co., of New York City, and the Llewellyn Iron Works, of Los Angeles. The generators and more important electrical equipment were made by the General Electric Co., and the impulse wheels by the Pelton Water Wheel Co., of San Francisco.

C. O. Poole has been in charge of design and construction throughout, as chief engineer of the Pacific Power Corporation.

When Ship Freight by Motor Truck and When by Rail?

Economic Limit of Truck Haulage Depends Largely on Freighthouse Costs and on Distance of Local Haul

By C. C. WILLIAMS
Professor of Railway Engineering, University of Kansas, Lawrence, Kan.

COMPETITION of motor-truck haulage is becoming more and more a matter of serious concern on the part of the railways. Just as they have had to accept the competition of electric interurban railways for certain classes of traffic, they are now facing a similar competition from motor trucks on improved highways. It may be of interest, therefore, to consider briefly the extent to which such competition from the highways may affect the railways.

The vulnerable point of the railways is high terminal costs in handling freight. The shipper transports his goods over the route and by the means that enable him to lay them down at the consignee's door at a minimum total cost. After the goods are loaded on the freight-car, they can be transported much more economically per ton-mile than by motor truck, but the high cost in the former case arises in the handling at the terminals. Where the goods have to be loaded on trucks to get them to the station, they may as well, while they are on the trucks, be hauled by the trucks to their ultimate destination, provided the distance involved is not so great that the cost at the higher rate per ton-mile with a low handling cost exceeds the outlay via the railroad with its low ton-mile rate for actual haulage, but high terminal expense.

Derivation of Formula

Stated in the form of an equation, this condition may be represented as follows:

Let x = distance in miles beyond which railway transportation becomes more economical than truck haulage; T, terminal cost in cents per ton for handling at freighthouse at origin; T', same at destination; t, cost in cents per ton for loading and unloading freight on a motor truck; c, cost in cents per ton-mile actual haulage on railroad; C, same on motor truck, and m, distance in miles of local drayage to and from the railroad. Then

$$T + T' + cx + mC + 2t = t + Cx$$

or

$$x = \frac{C}{C - c}m + \frac{T + T' + t}{C - c}$$

The problem now is to determine the amount of each of these items upon which the distance x depends, for the equation represents the economic basis of adjustment regardless of whether the rates are charged in accordance with the actual costs or not.

Freighthouse Costs

While the cost of handling freight through a freighthouse is extremely variable, depending upon the size of the house, average trucking distance, method of trucking, organization, etc., it averages from 15 to 45c. per ton, the former figure applying to a small rural house and the latter to a large city freighthouse with inefficient methods. Perhaps 20 and 40c. per ton would represent average costs for small and large freighthouses respectively.

The cost t of loading and unloading freight on trucks is difficult to estimate. On the average it would probably amount to about 25c. per ton, judging from some observations recently made by the writer.

Ton-Mile Costs by Motor Truck

The cost of transportation of general freight per mile by motor trucks can be roughly estimated as shown in the accompanying table for a $1500 truck of 1½ tons capacity, operating loaded 7500 miles per year. (This is one-half the total mileage, because the truck almost necessarily runs empty in one direction.)

ESTIMATED TON-MILE COST OF HAULING FREIGHT BY MOTOR TRUCK

	Per Mile	
Fixed Charges		
Interest on investment at 6%	$90	
Depreciation at 12½%	190	
Storage in garage, or rent	50	
Total fixed charges per year	$330	
Same per ton-mile		$0.030
Operating Expenses		
Driver's wages	$0.100	
Gasoline, 7 miles per gal	.030	
Lubricants	.001	
Tires	.020	
Garage attendance	.005	
Other repairs than tires	.010	
Licenses and taxes	.002	
Injuries and damages	.001	
Total operating expense per car-mile	$0.169	
Same per ton-mile		0.113
Total cost per ton-mile		$0.143

The cost of actual haulage for this class of freight on the railroad is small and does not affect the result greatly. It may be estimated at 0.5 cent.

The above data would give as the limit of economical haul for motor trucks for these conditions

$$x = \frac{0.143}{0.143 - 0.5}m + \frac{40 + 20 + 25}{0.143 - 0.5} = 1.03m + 6.2$$

or roughly,

$$x = m + 6$$

Economic Limit Stated

The approximate statement may be made therefore that the economic limit of truck haulage is the distance of local haul to and from the stations plus the terminal cost (including loading and unloading once) divided by the cost of truck haulage per ton-mile, for within this distance the

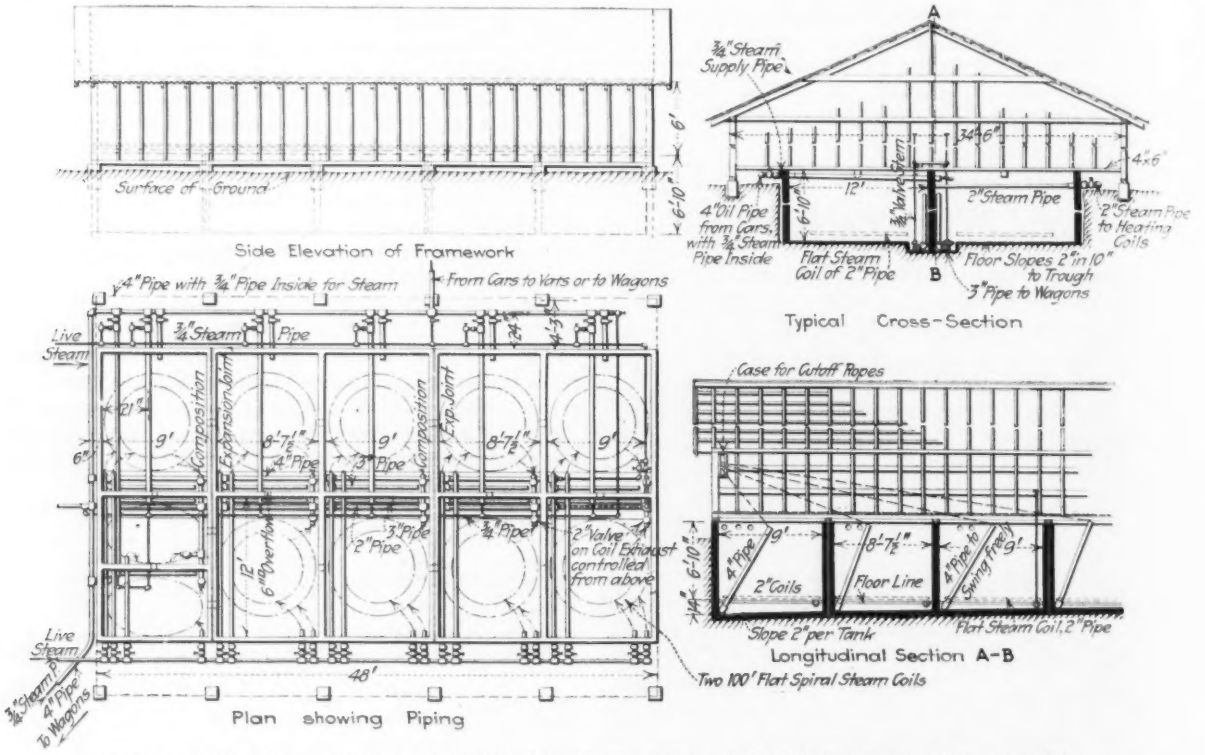
cost of actual haulage on the railroad is negligible. In the case of extraordinarily high terminal costs, such as at New York (see *Engineering News* of Mar. 3, 1910), the limit of economic haul would be much greater than the above data would indicate. The handling of perishable commodities, also, such as fruit and vegetables, may make the saving in time an additional factor that will extend this economic limit by an amount equal to the value of the time saved divided by the cost of transportation per ton-mile by the truck. From the foregoing analysis, the desirability of reducing terminal costs becomes manifest, if the railroads are to hold the competition from motor trucks to a minimum. Owing to the impossibility of obviating terminal costs altogether, a certain amount of haulage by motor trucks for short distances will have to be counted on.

The case is a repetition of the struggle between the inland waterways of an early day and the railroads. The reason that the waterways, including both canals and rivers, were unable to compete against the railroads was not because the latter could transport commodities more cheaply after they were loaded, but because of the high terminal costs of such waterways in loading, unloading and drayage to and from the docks. The old waterways were very inelastic in their operation, and in a similar manner the railways are not elastic enough to meet the needs of the situation at the present time. Areas instead of only lines must be covered by the transportation system, and the motor truck is probably destined to supplement the railways in supplying this requirement. There is ample room for both the railway and the motor truck, and it is hardly necessary that either encroach on the field of the other.

Concrete-Road Oil Tank Filled and Discharged by Gravity

Placed Below Switch and Above Road, Steam-Heated Oil Flows from Tank Car and to Distributor Without Pumping

LOCATED with the view of serving the greatest mileage, a concrete oil-storage tank of eleven compartments, nine of which have a capacity of 5000 gal., and two, which take the place of one large one, each holding 2500 gal., has been built by the Davidson County Turnpike Board at Nashville, Tenn. The piping arrange-


Side Elevation of Framework
Surface of Ground
Typical Cross-Section
3/4" Steam Supply Pipe
4" Oil Pipe from Cars, with 3/4" Steam Pipe Inside
Flat Steam Coil of 2" Pipe
2" Steam Pipe
2" Steam Pipe to Heating Coils
Floor Slopes 2" in 10" to Trough
3" Pipe to Wagons
Plan showing Piping
4" Pipe with 3/4" Pipe Inside for Steam
From Cars to Vats or to Wagons
Live Steam
3/4" Steam Pipe
Expansion Joint
Composition
Exp. Joint
2" Valve on Coil Exhaust controlled from above
Longitudinal Section A-B
Case for Cutoff Ropes
Floor Line
Slope 2" per Tank
Flat Steam Coil, 2" Pipe
Two 100' Flat Spiral Steam Coils

FROM 2500 GALLONS TO 50,000 GALLONS STORED, HEATED AND HANDLED WITHOUT PUMPING

ments, both for steam and oil, are such that a single compartment can be heated and emptied, so that 2500 to 50,000 gal. may be heated economically in the same length of time.

Filled and Emptied by Gravity

The railroad switch is on an embankment at an elevation about 1 ft. higher than the top of the tank, and the road on which the 1000-gal. motor truck pressure distributor stands while filling is below the embankment. The dimensions of the larger compartments are 12 ft. by 9 ft. 6 in. by 6 ft. 10 in. high at the outside walls, with a 2-in. bottom slope to the middle of the tank where there is a trough 2 ft. wide and varying from 10 to 14 in. in depth. In the middle of the trough is a longitudinal wall which divides the tank into two rows of compartments. The 4-in. feeder oil line, with a branch running into each pair of compartments, is kept warm by an axially contained ¾-in. steam pipe from a 40-hp. boiler.

In each compartment there are two 100-ft. flat steam coils, each of the small sections having the same heating provision as the larger compartment, so that a small quantity may be heated in a short time.

The compartments are drained by pipes raised and lowered by ropes operating over sheaves in a central control box. The drain pipes fit by sleeve joints to a pipe located in the trough, one such pipe being on each side of the dividing wall. This is considered preferable to the use of valves as it is more accessible and obvious.

The tank is left open at the top, and a galvanized-iron building, on wooden studding, is built over the tank to shelter it.

The construction was done by the county's forces, much of it being accomplished at odd times when roadwork was halted. About one month was required for erection, and the cost was $3000. The plant was designed and supervised by W. D. Waldo, of Vanderbilt University, Engineering Department, and the construction was in charge of J. K. Rains, of the County Turnpike Board.

Value of Racine Water-Works Fixed at $1,015,000

Wisconsin Railroad Commission Settles Six-Year Contest on Reproduction Cost New Less Depreciation Basis—Capitalizing Net Earnings Unfair in This Case

Decision Abstracted by W. E. MILLER
Division Engineer, Staff of Railroad Commission, Madison, Wis.

APPROXIMATELY six years after the citizens of Racine, Wis., voted to buy the property of the Racine Water Co., the price that the city shall pay for the property was determined by the Railroad Commission of Wisconsin, under the provisions of the Public Utilities Law of the state, in a decision rendered Apr. 11, 1917. The proceedings before the commission were early interrupted by contests in the state and Federal courts, one suit being brought by a citizen of Racine and another by the company's bondholders. These and long continuances between successive hearings, by agreement of the attorneys for the parties, accounted for by far the greater part of the time involved.

The city, by its principal witness, contended that the value of the company's property, as of the date of the revised inventory, Jan. 1, 1914, was $470,398. The company claimed a value for it of more than $1,600,000. The commission finds the value as of Mar. 1, 1917, including very considerable additions to the property made subsequent to Jan. 1, 1914, to be $1,015,000.

Four Independent Valuations Made

Four separate and independent valuations were before the commission, one having been prepared by the city's principal witness, two on behalf of the company and one by the commission's engineering staff. The company's valuations were prepared by Allen Hazen and by George W. Biggs. Including only the physical property, the four compare as follows:

	Reproduction Cost New	Same Less Depreciation
City	$686,925	$470,398
Hazen	1,233,217	1,162,631
Biggs	1,513,123	1,425,204
Staff	1,005,021	929,301

Following its usual practice, the staff of the commission left for determination by the commission the items of cost of securing capital (bond discount), and going value, or value of developed business. The physical property only is considered by the staff. The city's witness recognized no value beyond that of the depreciated physical property. In addition to their values given above for physical property, Mr. Hazen and Mr. Biggs estimated going value at $150,000 and $138,246 respectively. Mr. Biggs made a further addition of $101,418 for discount on bonds, which brought his final totals to $1,760,927 without depreciation and to $1,665,497 with that taken into consideration.

After analyzing and estimating all the elements of value separately, Mr. Hazen placed the final figure at $1,550,000 upon the basis of the net earnings of the business, capitalized at 5½%. It was this theory of valuation which the company sought to have accorded the greatest weight.

Practically No Allowance Made for Paving

All of the four estimates of reproduction cost were based upon existing physical conditions and therefore took account of all paving over the company's pipe system. The city's valuation differed from the others on this point fundamentally in that it included allowance for disturbing only such paving as could not be avoided by the plan of generally laying the water mains under the parkway spaces between curbs and sidewalks. The commission found that $850 would doubtless cover the expense of removing and replacing all of the paving actually encountered by the company in its work of laying mains originally, and in view of decisions of the state and United States Supreme Courts and others concerning the paving item in reproduction-cost estimates, $850 is all that was included therefor in the commission's finding. Mr. Hazen had included $152,422, Mr. Biggs, $148,729, the staff, $101,229, and the city, $29,324 for paving expense in connection with a present construction of the system of mains. Mr. Biggs alone had a further allowance ($56,851) for paving over service pipes, although these were laid by plumbers at consumers' expense. His total paving allowance was therefore $205,581.

The commission points out that, when all but $850 of Mr. Hazen's allowance for paving is deducted and certain other obviously proper corrections are made, his estimate, without overhead general expenses, is only $41,509, or 5.2%, above the corresponding figure arrived at by the commission. When his own percentages for overhead general costs are applied to his estimate corrected as before indicated, the reproduction cost new for the physical plant, without depreciation, becomes $1,018,839.

Capitalizing Net Earnings Proposed by Hazen

Referring to the method of valuation by capitalization of net earnings, the commission then says:

Hazen, however, puts the fair value of the property of respondent as of Jan. 1, 1914, at $1,550,000, and his conclusion is based upon two assumptions: (1) That the present water

rates are reasonable and maintainable indefinitely; (2) That it follows from the first proposition that there is assured a fixed safe income, as shown by present accounts and so free from risk that it should be capitalized at about 5½%, because "the value of the plant is represented by the amount of money which could be invested in stocks and bonds equally as secure and desirable as the stock and bonds of the Racine Water Co. that would yield an income equal to the maintainable net earnings of the company." The stocks and bonds, he assumes, will pay about 5½%.

The respondent company serves consumers under a law that establishes no permanent rates. The life of its franchise or right to do business is subject to termination at the option of the city. Such a situation is to be carefully distinguished from the situation of any utility having perpetual franchises and a contract right to maintain perpetually fixed rates.

Net Earning Capitalization Unfair Here

After pointing out that net earnings should be given consideration in arriving at final value, but that this "is quite a different thing from saying that the proper measure of valuation is the capitalization of net earnings where those net earnings are not guaranteed and the life of the utility as a private enterprise is subject to termination" the decision continues:

To our mind the fair value of $1,550,009 fixed by Hazen on a capitalized earning basis is a value arrived at solely on the hypothesis that capitalized earnings is the only practical method of arriving at fair values. We say this because such a value bears no relationship that we can see to the other elements of value which Hazen has arrived at, such as reproduction cost and reproduction cost less depreciation on any basis. We believe that the use of capitalized earnings as the sole or main factor in arriving at the fair value of public-utility property under the public-utility laws of Wisconsin leads to wholly erroneous results. It fails to take into account the fact that the earning life of the plant in question is terminable by these very proceedings; that the water rates have never been investigated and held reasonable; and that if they are yielding more than that rate of interest which will attract capital, they are unreasonably high. It assumes that the risk connected with the investment demands a high rate of interest in fixing rates in order to attract capital and at the same time assumes that the risk is sufficiently conservative and safe as to be attractive at a low rate of interest. Furthermore, in order to capitalize the earnings, we must first determine whether the rates are reasonable, which in turn we cannot do without ascertaining a fair value upon the property, unless we are to fix the reasonableness of rates by comparison with rates existing elsewhere, which means that the result arrived at is dependable largely upon the places selected for comparison. In this case we could, by selecting one city or another, either find the rates unreasonably high or unreasonably low. Now it is very certain that, though a plant is earning little, fair value should not be reduced to the vanishing point. That was not the position which this commission took in the Appleton case. On the other hand, where reasonableness of rates has not been determined and no application has been made to the commission to adjust rates, a possible privilege of receiving for the time being higher rates than are reasonable, resulting in a larger net income than we could hold to be justified, is not to be capitalized against those who have not taken proceedings to adjust rates.

However important or perhaps binding the question of capitalized earnings may be as regards those properties which are assured indefinite, fixed and absolute returns, capitalized earnings cannot be considered as the controlling factor in arriving at ultimate fair value in a case like the present. This does not mean that such earnings are to be disregarded, but they are only to be given that consideration with other factors to which they are entitled.

Value of Additions

The value of additions made to the property between the inventory date (Jan. 1, 1914) and Mar. 1, 1917, without overhead general expenses thereon, was covered by stipulation of the city and the water company. With the overhead costs allowed by the commission (15%) these aggregated $88,206 and are included in the final award.

Since the courts have held that historical cost is of evidentiary value in determining proper compensation in similar cases, the commission endeavored to ascertain the historical cost, including early deficits in earnings below a fair return. The records of construction cost of the original plant, built in 1886-87, were not available. Some important figures relative to costs, or rates of cost, of the principal items were, however, available, such as contract price paid for pipe per ton, cost of water tower, etc., and materially assisted in determining approximately the amount of money then invested. That amount was estimated at $385,000, but it appeared that 15-year 6% bonds to the amount of $400,000 had been delivered to the construction company for the building of the property.

Deficit Table

The commission's so-called deficit table starts with $400,000 as the original investment and shows for each year the net charge against the plant after debiting additions and improvements, operating expenses, taxes, depreciation and 7% interest on previous balance, and crediting it with the earnings. Deficits are therefore measured by net earnings as compared with a 7% net return. They accumulate with compound interest and are reduced by later net earnings in excess of 7%. On this basis the commission finds the cost of the property had grown to $974,885 on June 30, 1914, six months beyond the inventory date, since which the value of additions to the property was covered by stipulation. In this deficit table the yearly additions include bond discounts as charged by the company, aggregating $96,679 subsequent to the original $400,000 bond issue. They also included other items that were regarded by the commission as improper capital charges. The conclusion was that the actual legitimate cost from the beginning, including 7% interest deficits, was considerably under $974,885.

The commission's finding is quite close to the mean of the values claimed for the property by the city and the company, yet in view of the thorough analysis of all items and elements presented by the commission, it can hardly be said that they merely "split the difference" and made a compromise valuation.

New Steam Hoists Are World's Largest

The hoist recently built for the Homestake Mining Co. and now in regular service is the largest compound steam hoist in operation. It has duplex inclined cylinders, 28 and 52 x 42 in., driving two shafts linked with side rods. The cylinders meet at the apex of the triangular frame. The Homestake hoist will be surpassed in size, however, by a new machine now under construction by the Nordberg Manufacturing Co. for another mining concern. This latter hoist will not only be the largest compound condensing hoist built, but in regard to capacity and depth will be the largest hoist in the world—in this surpassing the four-cylinder noncondensing hoist of the Tamarack Mining Co., made 16 years ago. This new unit will have two high-pressure and two low-pressure cylinders, 32 and 60 in. in diameter, with a 66-in. stroke. The cylinders are placed at the base of the triangular frame with their rods running to a common crankpin. The drum will be of the cone-cylinder type, 16 ft. at the small diameter and 30 ft. at the large. This hoist is designed to handle 10 tons of ore from an ultimate depth of 10,000 ft., the shaft being inclined at an angle of between 35 and 54°.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Superintendent, Out on Job, Summoned to Telephone by Auto Horn

By SAMUEL WARREN
New York City

THERE IS usually a telephone on a construction job—and it is often a great bother to the timekeeper or material clerk to have constantly to go out on the job and find the superintendent or the person wanted to answer a call. If the calls are long-distance ones, the person must be summoned immediately. The trouble is easily solved by putting on the outside of the shanty a Klaxon automobile horn operated by a push-button near the telephone. Give the men likely to be called a particular buzz, such as two short or three long. In this way they can be found in far less time and with far less trouble than by sending someone after them.

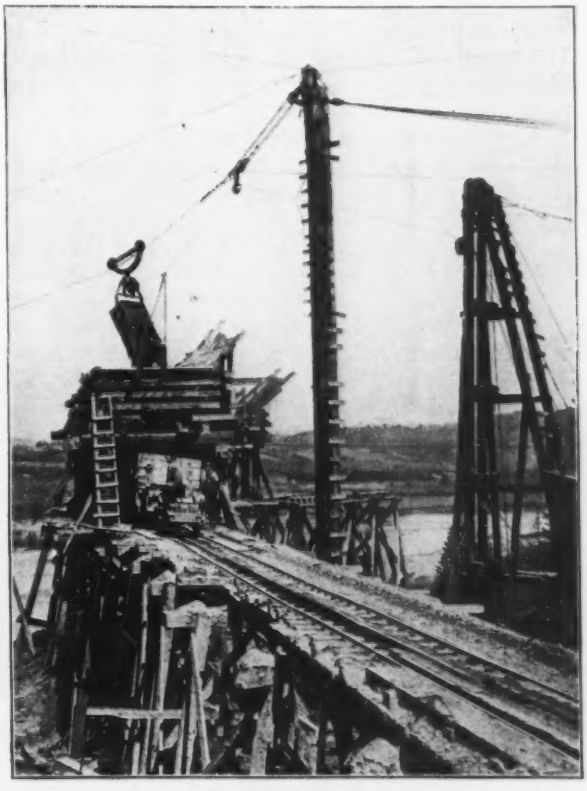
The writer adopted this scheme where the shanty was across a busy street from a 10-story building that was being erected. In spite of the fact that there was much automobile traffic using similar horns in the street, the distinctive call repeated a few times invariably brought the man wanted. The horn cost $2.50 second hand and required four dry cells for its operation.

Simple Rigging Enables Derrick Hoists To Operate Draglines

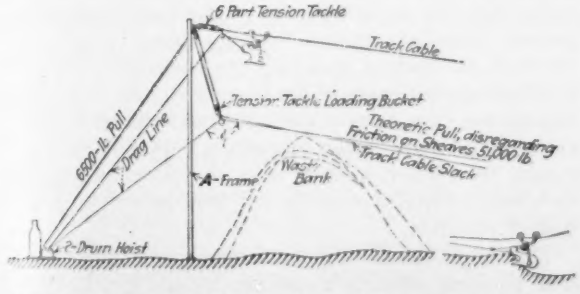
By F. T. CROWE
St. Ignatius, Mont.

BY PLACING the idler sheave for the dragline cable at the outer end of the tackle for handling the track cable, the writer made it possible to use the heavy pull available with the track-cable falls to load the bucket. In this way progress on the construction of the Jackson Lake dam, in northwestern Wyoming, was greatly increased by operating a number of these improvised cableways with ordinary hoisting engines that could not, without this rigging, have exerted sufficient pull to load a dragline bucket of any practicable size. It is believed that even with a regular dragline engine this rigging could be substituted to advantage in hard digging for the usual practice of locating the idler sheave for the dragline at the top of the mast.

The dam, which is an earth and concrete structure across the Snake River, located 70 miles from the nearets railroad, in the heart of the Rocky Mountains, is at a point where equipment was difficult and expensive to secure. When, therefore, it became apparent that the earthwork was lagging seriously behind the concrete construction, it was imperative to put to work in some way such equipment as was already on hand to make up this deficiency. It had been intended to make the fills and dredge out the cofferdams and river channel with a 12-in. suction dredge; but though this equipment was run 24 hours a day, it still fell far behind its time schedule. The slack-line excavator was the type of equipment that was easiest to improvise out of the plant and materials available, as a large quantity of wire rope, blocks and derrick timbers, together with several hoisting engines, were on hand after the completion of derrick and piledriving work, which was well along. The hoists, however, were ordinary American 7 x 10-in. double-drum 20-hp. engines, which could not be expected to develop a working pull greatly in excess of 6500 lb. This would not be nearly sufficient to load a dragline bucket in the stiff digging expected.



DOG DRAGLINE DRUM AND USE TRACK-CABLE FALLS TO LOAD BUCKET



RIGGING GIVES HEAVY PULL WITH LIGHT HOIST

Under the circumstances the rigging mentioned, which is plainly shown in the drawing and photograph, was devised. In operation, after the bucket had slid down the track line to the loading point, the track cable was slacked to land the bucket, and a strain was taken on the dragline. This was dogged, and the back drum, on which was

wound the lead from the track-cable tackle, was taken up. In this way a high tension could be produced in the drag cable without straining the hoist. If, for instance, the angle ϕ, indicated on the sketch, were 135°, a pull of 6500 lb. on the lead part of the track-cable tackle would produce a pull of 25½ tons in the drag cable, neglecting friction. This was sufficient to load the bucket in any material, after which the dragline drum would be released, the track cable tightened, and the drag line used to pull the bucket to the dumping point. After a little practice with this type of rig, the operators were able to manipulate it as fast as can be done with a standard slack-line equipment.

This rigging would present an advantage even with larger outfits especially designed for slack-line work, when hard digging, such as stiff gumbo or cemented gravel, is encountered. It would be possible to lag the dragline drum with this rigging, because the loading would not depend directly on the power of the hoist, and considerably greater speed could be secured in this way in conveying the bucket.

The Jackson Lake dam was built by the United States Reclamation Service, under the direction of the writer as superintendent of construction.

Air Jet Cleans Pipe Piles on Philadelphia Subway

A THREE-INCH jet nozzled down to 2 in. is being used under 100 lb. pressure to clean out sand and gravel from the pipe piles being driven in Philadelphia to support the walls of the City Hall station of the new subway. The piles being filled with water, the jet acts as an air lift, blowing the sand and gravel out of the top of the pile with considerable velocity into the underpinning pit. While one pile is being cleaned, it is necessary to cap the others driven in the same section to prevent filling them. The piles, which average 18 or 19 ft. penetration, are driven several feet at a time and then cleaned out with the jet to the bottom. Care is taken not to allow the air jet to get below the bottom of the pile, for fear of drawing in material from beneath the building. With one or two piles which struck, however, it was possible to start them again by cleaning out 6 or 8 in. below their bottoms. After the piles reach rock, the jet is again put in and cleans out the pipe perfectly, removing everything except the hard rock.

The jets are not worked into the material, but simply lowered until they touch the sand, when the pressure is turned on full force. The dirt that is blown out of the piles is cleaned out of the wall pits later by shoveling it into buckets.

Pyramid Frame Stiffens Long-Span Support for Templet

A STIFFENING support for a templet to hold bolts anchoring down a 140-ft. standpipe while the concrete was being poured around them consisted of a pyramid frame erected over the excavation, as shown in the accompanying photograph. The standpipe is 10 ft. in diameter and rests on a truncated-cone base 10 ft. deep and 20 ft. in diameter above a 2-ft. sub-base 22 ft. in diameter. The top of the concrete foundation is 12 ft. in diameter. The twelve anchor bolts extend above the base through loosely fitting sleeves riveted to the shell. They were set in the concrete in the usual way in pipe sleeves, but the immediate support for the templet consisting of six 6 x 6-in. timbers spanning the excavation was not rigid enough without additional support. As larger long timbers were not handily available and it was not desirable to imbed posts in the concrete, a pyramid frame was erected from which a beam under the center of the long span was suspended after it had been jacked up to the desired elevation.

TEMPLET FOR STANDPIPE ANCHOR BOLTS STIFFENED BY PYRAMID WHEN HORIZONTAL TIMBERS PROVE TOO LIMBER

This work was carried out last season at the Capitol Hill pumping station under the direction of D. G. Thomas, Chief Engineer, Denver Union Water Company.

EDITORIALS

Sane Thought in the Miami Valley

FLOOD control is so vital that it cannot safely be postponed, says Arthur E. Morgan, chief engineer of the Miami River flood-protection work. It is a sane and sound remark. The short and pointed letter printed on page 326—it was written in response to our inquiry—merits the study of every reader. The leaders of the boldest and most carefully thought out civil enterprise in the country are not in tune with those who unreasoningly clamored for stoppage of all construction work. To produce ships and war supplies we must have industrial cities; to maintain industrial cities we must protect them—the chain of logic is very direct. Just so must we have roads put in shape, railways kept in operative condition and made more efficient. Just so is it necessary—and vitally necessary—to keep up our national life and activities and principles as a whole. The more actively the nation maintains its organic life, the more vigorously can it prosecute its campaign.

Hold Engineer Students Back!

THE faculties and students of the engineering colleges of the country seem, by their reactions to the nation's present needs, to fall into two classes. In the one—incomplete observation makes it seem to be the smaller group—zeal for military service dominates, to the extent that numbers of seniors, juniors and even sophomores are encouraged to enter the army or navy. In the other group of schools the attitude is no less patriotic, but the pursuit of martial glory is restrained by a desire to render the most effective service that may develop—whether for army or navy or factory or farm. This attitude must be encouraged. *Engineering News-Record* recommends to the War and Navy Departments, and to Congress and the Council of National Defense, that the land-grant colleges be led to organize and coöperate for completing the training of the technical students now partially educated. More engineers, more chemists, more farmers, more purchasing and disbursing agents, are to be required for the government. It is folly to conscript them on the par with wholly untrained youth. Student engineers, farmers, chemists, should be exempt from service to attend college but should be held enrolled for any service that public weal may require when the college work can be completed.

The Engineering Council Is Challenged

THE direct accusation that it is undemocratic faces the Engineering Council. In the spirit of today we know of no charge more fundamental, none that calls more immediately for answer. Democracy is the battle cry of the day, of more than one day. Engineers as a body will organize, and their organization will be democratic, else it cannot be and cannot live. It will be free from caste spirit, free from narrowly centralized group control, free from intricate avoidance of direct representation. The individual voice will find expression in it. Such will be the organization, and such must be the Engineering Council if it is to constitute or represent that organization. We say this in blunt words in order to lay emphasis on the thoughts voiced by C. E. Drayer in our columns last week. Mr. Drayer's letter was a challenge flung at the council. There are some homely, substantial truths at the bottom of the challenge. It puts the burden of proof on the council.

Canada's Great Railroad Problem

CANADA has a tremendous railroad problem to solve. In the last 15 years she has indulged in a riot of railroad construction, aided and abetted by the most extravagant public gifts and guarantees—and it was only some three years ago that she was pulled up short by the refusal of the Grand Trunk to take over the National Transcontinental, and the scandal exposed by the investigation of the latter. The commission appointed to study the situation has just reported. Two of its members, as noted in the news section of this issue, recommend indirect government operation through a permanent board of five trustees. The trustees would control the roads in difficulty, which between them constitute a longitudinal half of Canada's railway mileage, the other half being the highly organized and efficient Canadian Pacific Ry. The third commissioner would ask the roads to work out their own salvation, but would make it easier by redividing them along geographical lines, eliminating the present destructive competition. Whichever recommendation may be the more sound, the point to be noted is that both are radical. Desperate cases require desperate remedies—especially in war time.

Warning to Us on Railway Relations

THE dilemma of our northern neighbor is not without its warning to us. The day is long past when we will make wholesale donations to our railroads, nor are we likely to permit wildcat construction such as has been the order of the day in Canada. It is not so certain that other circumstances, controllable or otherwise, may not bring some or all of our roads into equally serious difficulties. In such an event as drastic remedies as are proposed for Canada might be necessary in the United States, and here, as well as in Canada, the public would have to foot the bills. The railroads must be run—and running a railroad means constantly expanding it to keep pace with the growth of the country—even if no private capital will come forward to run them, and even if they cannot earn their fixed charges. The railroads and the public are inseparably linked, at least in bad fortune; the situation in Canada proves that.

Unity the Slogan for Engineers

THAT all stand by standing together is the one big teaching of the day. Other teachings will come, both of broad principle and of detail. But this one is with us now, and is clear and defined. As a nation and as component parts of a nation we shall advance according as we profit by this teaching and practically apply it.

For us the direct application is to the engineering profession. Engineers must stand together solidly, else they put aside the chance of having force and influence as one among the groups constituting the nation. They must place on their banner the motto: Unity. For at present they have no unity.

Engineers did not value unity in the past. They distrusted and shunned unity. What they strove for was segregation. Where they foregathered it was in separate groups, and the shrewd leaders of the national groups, seeing the trend of existing thought, established the gospel of segregation even in the smallest local groups and in the nurseries of engineering, the technical schools. These leaders still continue to foster segregation, though thought has taken new directions.

A hitherto unnoticed spread of radical methods of thinking has taken place among engineers throughout the country during the past few years. Until then the engineering profession existed on an idea of professional necessity evolved many decades past. The number of engineers grew, but solidarity did not grow with number. In respect to organization engineers stood still. Unrest finally got a start—dissatisfaction with the stand-still condition. The unrest has made rapid headway.

There are specific reasons for this spread of a new spirit. To combine them in a single one: The individual engineer came to realize that he stands alone in the world, in all except the one point of technical fact—in substance a text-book matter. Just as his text-books lay on the shelf, rarely consulted, so he came to feel that his technical fraternizing is of little use to him in the daily fight.

The individual engineer stands alone today, as he has for years. But today he feels this condition, and knows it to be bad, a weakness and a symptom of disease. That is the new spirit, a semiconscious, half-formed demand for professional unity.

The year 1917 strikes a sudden sobering blow with its imperative claim for efficiency, hard work and coördinated effort. The impulse reaches the engineering profession as it does all else. It is powerful enough to overthrow and destroy. Whatever institutions and conditions exist only by virtue of a varnish of antique respectability are likely to fail.

The present segregated, stratified organization of engineers is in danger of giving way under this stress. It may remain as a dead husk, but the life will be elsewhere, in some form of association that represents engineering unity. Evolution toward unity, therefore, is the necessary tendency of the profession at this time.

Beginnings have been made in organizing for unity. Trial of different modes of organization has been started, with much thought and with wholly sincere effort. But as it is not given to every man to grasp the clear drift of new tendencies, so in these times of change we find varying degrees of understanding and sympathy applied to the organizational attempts. That one will survive which either in present form or by re-creation shall most fully embody the spirit of unity. But none need survive, indeed, if existing professional organization will promptly realign itself on the course of democracy and unity.

Whatever the successful movement, it will express the truth that unity as demanded today is the uncompromising foe of stratification. To have unity of purpose, to attain professional group-strength and stability, it is necessary to find the interests common to all engineers, low and high, and exclude all other interests from consideration. Existing professional organization has failed to meet the need because it has not discovered these common interests elsewhere than in technical discussion.

To make out of the country's great army of engineers an engineering profession is the work that must be done in the immediate future. *Engineering News-Record* stands with all who labor in this enterprise.

Everything at Once

IN THE onset of the great present emergency, with so many problems pressing for immediate attention, it is hardly fair to assail such bodies as the Council of National Defense or the Naval Consulting Board for forgetting, in their inventories of the country's industrial resources, to list the means by which those resources can be expanded where necessary. Yet, so far as can be found out, practically nothing has been done toward organizing our construction forces. The services of members of one or two large contractors' organizations which took the initiative and compelled attention from the authorities have been accepted. Note was taken of the names of a few individual firms that managed to get in touch with a responsive official. In one small section of the Pacific Coast an inventory of contractors has been ordered. This appears to be about all.

Presently it is sure to develop that new construction is vitally needed in certain industrial lines. The work may not be located on the New England nor yet on the California coast—and the Government will not know where to turn to find contractors, nor how to select the firms which can be pressed into service without disorganizing other necessary work. It is one thing to fling a percentage contract blindly at the first man available, another to know where to find the efficient man, ready to turn out quality work at record speed.

It is to help this situation that *Engineering News-Record* asked for a show of hands among contractors, as announced in our issue of May 3. The progress of the count is noted on page 330.

Swamped by a great paper flood, the various departments and organizations at Washington—official, semi-official and wholly unofficial—are struggling to get something done, and do the most necessary things first. Internal affairs have had little chance for attention, under these circumstances. Apparently the mobilization of construction resources was regarded as a wholly internal matter. But this view, were it to be the permanent one, would prove seriously harmful to the country's welfare.

Since the protest against stoppage of road work that was voiced in these columns last week, many far-seeing men have spoken out strongly for the urgent need to keep up the country's vital activities in full measure. The first

hasty conclusions that the nation could simply stop all else and stand up with sword and gun till victory is assured are being reconsidered. In the strain of the emergency our national thought is clarifying daily. Hard-headed engineers and contractors are helping in the process. If they stand together and think together they will safely overcome all remaining impulses that would paralyze our country's economic life.

The Only Safe Way Is To Charge It Off

THE tearing down of a refuse incinerator built at Los Angeles a dozen years ago suggests questions as to what depreciation allowance should be made in figuring annual charges for garbage and refuse disposal by burning. To begin with, it should be noted that the Los Angeles incinerator was not in full active use for even ten years. To what extent this was the fault of the builder and to what degree of the city we cannot state. Apparently, there was some blame on both sides. The main point, however, is that ten years or so after construction the incinerator went for junk and that it might well have gone that way sooner. Moreover, this particular furnace succeeded another one at Los Angeles ten years after the first was built.

This is not all. The experience of many other American cities has been similar to that of Los Angeles. It would be a reasonably safe guess that between plant breakdown and changes in local notions as to garbage and refuse incinerators, from their first use in the late '80's to date, has been less than ten years. This short life has been largely due to the general failure of municipalities to secure competent engineering advice, or in fact disinterested advice of any kind, in the selection, location, design and construction of refuse incinerators. They went ahead blindly, in most cases.

With the aid of a competent engineer from the inception of the project until and after the incinerator is put in operation, certainly a ten-year depreciation period ought to be safe; but it is doubtful whether the time has yet come when more than fifteen years, if as much, should be allowed as an incinerator's life. With such a short life and heavy depreciation, it is obvious that, in figuring the annual cost of refuse disposal, capital charges make a heavy addition to operating expense. Yet what city official, except now and then an engineer, ever takes capital charges into account when reporting cost of refuse disposal?

Use More Labor-Saving Machines in Construction

WHEN the services of all classes of men are at a higher premium than ever before and the utmost economy and efficiency have become a universally sacred duty, labor-saving machinery should be used whenever possible in every field of industry and life. Every captain of industry, engineer, public official and—most important—every farmer should take this duty to heart, concentrate his best thinking and his strongest will power upon pressing more labor-saving machinery into use and getting higher efficiencies out of every machine in service. Brief practical experiences and suggestions on such phases of this subject as are within the control or influence of our readers will be welcome.

To start the stream we present elsewhere in this issue notes from Maine to California on the use of trenching and backfilling machinery in water-works, sewer and other municipal construction. The notes show that while the opportunity to utilize these labor-saving machines has been neglected in some quarters it has been seized upon in others. In still others sheer necessity, in the form of scarce, high-priced labor, has forced its use. The pressure is now increasing and will continue to increase through the present and perhaps for many working seasons. Most encouraging it is to see that machines are actually being used in some places in spite of obstacles considered unsurmountable in others.

Commanding as is the extension of labor-saving machines just now the resulting gain will not end with the present emergency. It will continue to save money and to release laborers for less arduous, more pleasant and better paid tasks than digging trenches or doing other kinds of unskilled manual labor. It is because better positions have been offered in abundance that cities and contractors are being forced to use trenching and other labor-saving machines—to their own as well as their employees' advantage.

Engineering Efficiency Wins At Least Once

UNDOUBTEDLY a chill came to the hearts of certain Iowa legislators when they realized that their "Pitt-Johnson" road bill, abolishing the State Highway Commission and returning to the more easily manipulated plan of local control, had been defeated through intelligent publicity work by engineers. It must have been somewhat of a surprise to find that the old methods of "log rolling" and "fence building" are antiquated as methods of controlling votes when the cold facts of actual accomplishment are placed before the electorate in such a manner that not even the most hardened partisans dare to deny their force. And to have this accomplished by men of a laboratory and school-trained profession, unversed in the ways of this sad and wicked world! Truly, the supporters of the Pitt-Johnson bill had it "coming to them"—and it came.

The day of the small politician is passing. He must be alarmed to find that the reformer, whose discomfiture was so easily accomplished, has been succeeded, not by another set of visionaries, but by the calm, fact-dealing engineer and builder—for the definitive quality of the work of these men is that failure is not tolerated. Their work must stand the coldly critical examination of anyone. Its faults cannot possibly be hidden, nor can its benefits be distorted. Where the politician shammed and bluffed his way through, the engineer progressed by performance.

When the men who design and build come to an acceptance of this truth, there will be born a new attitude toward public life; and this change can be nothing but beneficial. The day when the profession, unashamed, will take action as a unit in those affairs through which it touches the community will definitely mark the beginning of better social conditions.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Needed: Accounting for Public Waters

Sir—Water is a public resource, but there is no accounting for it imposed on individuals or concerns that employ it. The needs of national economy and the principles of fair dealing require that this condition should not longer prevail.

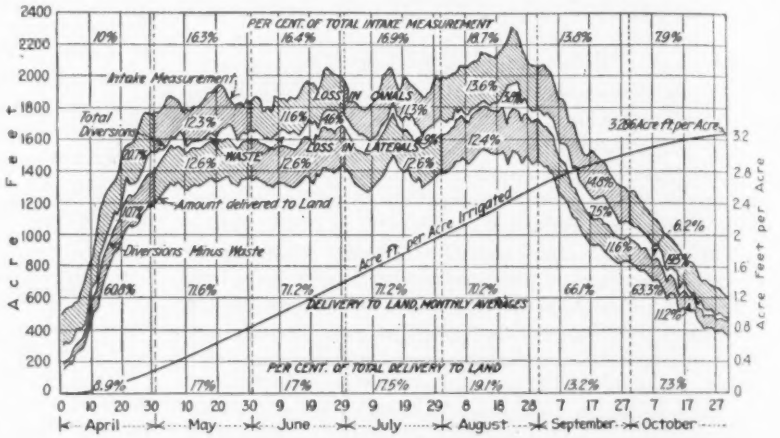
The ownership of water cannot be vested in the individual. It is a mobile resource, the disposition and control of which must be retained by the public. In other words, "beneficial use" of water for irrigation, water power, municipal supplies, etc., must be the measure and the limit of the right of the individual. This principle is fully recognized throughout the country, and there now exists on the statute books of nearly all the Western States some comprehensive form of water laws, prescribing a definite procedure whereby a right to the use of water may be established. The courts have almost uniformly upheld the constitutionality of these laws and verified the principle of public ownership and control of water-supplies. If, then, the individual be granted the right beneficially to use public property, should he not be obliged to account for it? If he does not account for water taken from public sources, is not our principle of "beneficial use" a theory and not a fact? Public officers having control of public funds are placed under bonds to account for every cent of money placed in their hands. Yet individuals are intrusted with a resource that in some localities is invaluable, with no thought of demanding an accounting therefor.

The writer believes that, if every irrigation company, every water-power company, every city, every individual ditch owner, were obliged at the end of each year to render an account to the state of the disposition of waters taken by him from public sources, very substantial economies in the use of water would follow. Particularly is this true of irrigation in those intensively irrigated portions of the West where every drop of water must be put to its fullest use. The mere knowledge that the disposition of an irrigation company's draft on the stream was to be scrutinized would lead that company to take stock of its losses and prevent them. The state in turn would refuse to allow a company to divert water that was not being put to its fullest use.

So vital is this question that the writer believes that, if such an accounting system were in force, *the irrigated area of the West could be increased 25% at little or no cost.*

It is refreshing to learn that some companies in the West have seen the importance of this principle and, although not demanded by the public, have prepared a sort of yearly "balance sheet" in the form of hydrographs, showing in simple concrete form the actual disposition of all water taken by them from public sources. As an illustration the accompanying sketch is the account of the Sunnyside Canal, which diverts from Yakima River in the State of Washington, maintained and operated by the United States Reclamation Service.

The thing is so simple that explanations are almost superfluous. The upper line shows the daily diversion from the river, the second line the amount diverted from the main canals. From this has been deducted the amount returned directly to the river through wasteways, giving the third line. The fourth line shows the amount actually delivered to farm units. The difference between the first two lines is the seepage and evaporation losses in the main canals, and between the last two the losses in the distribution system. The average quantities for each month are given in percentages. For the entire season we find:



ACCOUNTING HYDROGRAPHS OF SUNNYSIDE CANAL SYSTEM, WASHINGTON

Per cent. of total irrigated: Seepage and evaporation from main canal and branches, 14.0; waste from various wasteways, 5.1; seepage and evaporation from lateral system, 12.1; amount delivered to land, 68.8; total, 100. Total area irrigated during season, 73,000 acres

	Per Cent.
Total seepage and evaporation losses	26.1
Total waste	5.1
Delivered to the land	68.8

The last figure may be considered the efficiency factor of the system, and we may say that in 1916 the Sunnyside Canal was 69% efficient.

Every other canal system diverting from Yakima River has a right to just such information from every other system, and this is true of hundreds, in fact thousands, of other streams of the country. The only way this information can be secured is for the state to demand it from every system and make it a matter of public record.

Portland, Ore. J. C. STEVENS.

The Annual Cost of Improvements

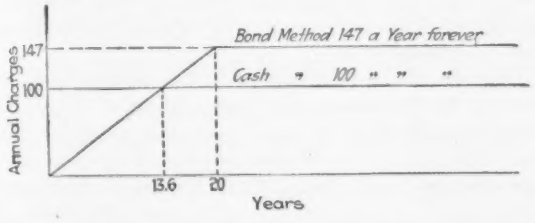
Sir—The writer's attention has been directed to Mr. Connell's interesting article on municipal finance, on page 419 of the *Engineering Record* of Mar. 17, 1917, but he begs to take issue with some of the inferences drawn and also with some of the assumptions made. E. P. Goodrich, in the *Engineering Record* of Nov. 28, 1914, outlined a similar discussion on the financial policy of New

York City, and the writer has drawn upon his ideas with some important modifications.

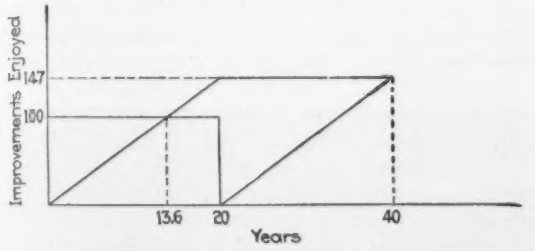
First let us consider, as Mr Connell has done, only one improvement, and the taxpayer's share at $100. Under the bond system the sum of amounts paid in 20 years is $147 (or an annuity of $7.35), but no account has been taken of the value of this annuity to the taxpayer. The present worth of an annual annuity of $7.35 is $100, so that there is absolutely no benefit one way or the other to the taxpayer on the basis of present values.

The matter of investment is also incorrectly shown. If the taxpayer has $100 a year income, he can finance the improvement in two ways. Under the bond method he would have to pay $7.35 a year, and this would leave him $92.65 a year to invest during the 20-year period. Now an annual annuity of this amount at 4% would yield $2759 in 20 years. If he paid cash, he would pay $100 the first year and nothing during the rest of the period; and he would have the use of $100 a year for 19 years, which would yield $2767, a slight advantage in favor of the cash method.

Now all the discussion up to this point has been on the basis of only one improvement. Let us go a step farther. These improvements are recurrent; let us suppose that this amount, $100, is required annually, which more nearly approaches actual conditions. The cost to the city, and therefore to the taxpayer, is shown by the following diagram:



On the other hand, suppose we have $7.35 a year and want to get the most for it; the relation of the two methods is shown as follows:



If we elect to borrow the money, we can get *at once* $100 worth of improvements lasting 20 years and no more, as shown by the rectangle above, or 20 × 100 = 2000 improvement-years. But if we buy only as much as we have cash for, we get $7.35 worth the first year, $14.70 the next, and so on. In the fourteenth year we would have $102.90 worth, and $147 worth the twentieth year. As each improvement started a year later than the one before, it would last one year beyond at the end, and conditions would be as shown by the parallelogram above, where we would enjoy 147 × 20 = 2940 improvement-years, or an advantage of 47% over the bond method.

In regard to the buying of short-lived equipment out of long-term bonds, the writer wishes to record his dissent in a most emphatic manner. We have had considerable discussion of this phase of municipal finance in Massachusetts, and communities are now limited to serial bonds, the term of which must not exceed the life of the improvement.

While the writer has no means at hand for checking up the estimated economical life or the maintenance cost in Philadelphia, he is confident that they would not err on the side of safety if applied to Boston conditions.

The adoption of a financial policy certainly involves many other considerations than those given, but the conclusions drawn from Mr. Connell's article might lead one to suppose that the pay-as-you-go method is in error and that a general extension of loans is in order.

The writer would view with alarm the adoption of such a reactionary policy, which would offer to the venal politician undreamed-of opportunities for raids upon the city treasury at the expense of posterity.

ADOLPH J. POST,
Assistant Engineer, Highway Division,
Boston, Mass. Public Works Department.

Macadam as a Base for Concrete Pavement

Sir—I have seen much criticism offered regarding macadam roads and their shortened days of usefulness since the advent of heavy automobile traffic, so I thought it might not be out of place to give a few particulars relative to this work drawn from my experience. I was much interested in an article in *Engineering News* of Mar. 1, p. 345, entitled "Old Macadam of Little Value as Base for Concrete Pavement"; but on reading it through and after noting the editor's footnote, it was not difficult to see wherein lay the weakness of the old macadam in question.

Before coming to Canada, I was assistant engineer for the Corporation of Dundee, Scotland; and while in the employ of that city I saw many changes in its streets and road building, but never did I see a macadam road in such poor shape that it was of no use as a base for permanent work. In that part of Scotland the rock is a bastard granite known as whinstone, very tenacious and hard to crush. Where a stretch of macadam road was to be built, 16 in. of this rock was put on in three distinct layers, rolled and blinded, and the top surface finished off with the clean screenings from the crusher.

When I commenced operations here in Fernie, which is situated in the Crowsnest Pass of the Rock Mountains, I simply followed the same procedure to which I had been accustomed in Scotland. Our business blocks are 300 ft. long, with a street width between sidewalks of 48 ft. Excavation was carried to a depth of 12 in. below the finished grade—grade stakes being put in with an instrument, so that the excavating was done exactly to the curvature of the finished macadam. Our rock-crushing plant, placed close to a stream from the bed of which we picked all the boulders available, was set to the largest size. The crushed rock was spread on the roadbed flush with the grade stakes, and the roller kept on until the rock had gone down 4 inches.

The surface was then blinded with dirt, watered and rolled again until thoroughly consolidated. A top coat of

4 to 5 in. of 2-in. rock was afterward spread, blinded, watered and rolled until the dirt was all brushed in like liquid cement and the smooth surface would stand up to the roller wheels without showing the least impression of a wheel mark. After the road had dried out, which took from four to six days, the stone screenings from the crusher were spread very sparingly over the surface and rolled in. The road was then opened to traffic.

In my opinion, one or two features in connection with this work are worth mentioning. First of all, I had a good road man in charge of the actual macadamizing, a man who had followed this work for 20 years in England and who could keep so well to the grade stakes that the finished surface showed no irregularities. Secondly, the dirt used for blinding was a mixture of fine sand and light loam, which, when wetted and brushed in among the rock and allowed to set, had many characteristics resembling cement. So far this has had the effect of keeping the top rock from becoming loose and thereby making holes for water to lie in. Lastly, the rock was laid to such a depth that traffic of any description, with the exception of automobiles, has little wearing effect on the road surface. I have no hesitation in saying that, when it becomes necessary to construct a permanent concrete or bitulithic pavement, the macadam foundation will certainly be of value as a base for such work.

There is no doubt that heavy and constant automobile traffic has made ordinary macadam roads take second place to many more lasting types of construction; but in the smaller communities, where property owners do not want to pay heavy taxes for 15- or 20-year debenture issues for street work, the waterbound macadam, if well put in, will stand ordinary traffic and give good satisfaction until such time as the community reaches that stage where it can afford to replace the macadam, or rather build upon it, a more lasting surface.

WILLIAM RAMSEY, C. E.,
Fernie, B. C. City Engineer.

Different Estimates of Brake Load

Sir—Referring to the editorial query entitled, "What Is Brake Load on a Bridge?" appearing in your issue of Apr. 12, the writer wishes to draw your attention to the following quotation from pages 283-284 of Dr. J. A. L. Waddell's "Bridge Engineering":

> Many designers think that the thrust of a braked train comes so seldom on any structure and its effect on the cross-girders is so small that it may be ignored; but this idea is incorrect, because bridges in some locations are subjected to train thrust constantly, and every bridge is liable to receive it at any time. Moreover, if one will figure the effect on the flanges of the cross-girders, which have transversely a very small moment of inertia, he will be surprised to find how high the extreme fiber stress will run. For instance, taking a case that is far from being extreme and which, consequently, is unfavorable to the illustration, let us assume an average live-load of 7500 lb. per lin.ft. for a 30-ft. panel, and a coefficient of friction of 0.2, making the thrust on the cross-girder 45,000. If the length of the girder is 17 ft., and if there are four lines of stringers, the transverse bending moment will be $22{,}500 \left(\frac{17 - 5}{2}\right) = 135{,}000$ ft.-lb. $= 1{,}620{,}000$ in.-lb. Assume this to be divided equally between the two flanges, giving 810,000 in.-lb. per flange, and each flange composed of two 6 x 6 x $\frac{7}{8}$-in. angles, the web thickness being $\frac{1}{2}$ in. The moment of inertia of the two angles is about 90, consequently the extreme fiber stress will be $\frac{810{,}000 \times 6.2}{90} = 55{,}800$ lb. nearly. Of course, the partial continuity of the rails and guard rails will often tend to transfer some of the train thrust directly to the abutments and to the embankment, but when the approach is a wooden trestle it will have its own share of thrust to take care of, consequently too much reliance should not be placed on this assumed relief. It is far better to detail the lateral system so that the thrust is not carried at all by the cross-girders, especially as the extra cost of so doing is trifling.
>
> The proper detailing of the lateral system so that the train thrust is taken directly to the trusses or girders has the added advantage of relieving the floor-beam flanges from the bending which will be occasioned by the changes in lengths of chords under load. . . . The stresses in the flanges of the floor-beams from this cause are very high, unless provision is made, as outlined above, to relieve them.

The detail illustrated [Fig. 22fff of the book, showing lower laterals riveted to the bottom flanges of the stringers and a strut between stringer flanges at this point] is only now coming into general use, although it has been standard practice in our office for over twenty years.

You ask "What Is Brake Load on a Bridge?" and indicate that there is some doubt as to the correct coefficient of friction. If consideration is given to the above-mentioned stresses set up by braking thrust of trains, the writer does not think a 20% coefficient at all excessive.

F. H. FRANKLAND,
Associate Engineer, Waddell & Son.
New York City.

Sir—The subject of your editorial query of Apr. 12, p. 106, was discussed by the writer in *Engineering News* of Mar. 26, 1914, pp. 688-689. The horizontal static thrust of a braked train, there taken at 90% of engine weight and 70% of light car weight, with friction coefficient of 30%, was increased by 50% to provide for impact or dynamic effect.

Experimental determinations not being available, it is thought by the writer that this allowance can be well defended. Needless to say, it gives lower braking forces than 20% of the full loaded weight. In a few specific cases the force was about 10% of the design live-load.

A. W. BUEL,
New York City. Consulting Engineer.

Sound Judgment—Miami Flood-Protection Work Will Go On

Sir—It is the opinion of the directors of the Miami Conservancy District that the work of the district should go forward without delay, notwithstanding the war. E. A. Deeds, president of the board of directors, is a member of the Munitions Standards Board of the Council of National Defense. It is his opinion that the continued normal functioning of industry is the best assurance of our ability to prosecute the war successfully. If the industrial life of the country should be thrown out of gear, our ability to carry on war would suffer as surely as would our general welfare. Moreover, flood control is so vital to the Miami Valley that it does not fall in the class of public improvements which can safely be postponed.

It is interesting to note that while Dayton will pay about two-thirds of the cost of carrying out the Miami Conservancy District plans, the total cost to Dayton of this flood-protection work is approximately equal to Dayton's share of the cost of the war for one year, according to present estimates.

ARTHUR E. MORGAN,
Chief Engineer, Miami Conservancy District.
Dayton, Ohio.

THE ENGINEER IN FIELD AND OFFICE

A Department Devoted to Details of the Day's Work

Detroit Uses Larger House Meters

LARGER meters are being more generally used in Detroit. The ¾-in. size meters were first introduced last year, but Theodore A. Leisen, General Superintendent, in his annual report for the year ended June 30, 1916, states that there are nearly one-half as many in service of this size as of the ⅝-in. size. In the accompanying table giving the detailed costs of installation, the full cost of the meter is included.

COST OF INSTALLING METERS

Size, In.	Number	Average Labor and Cartage	Average Material	Average Cost
½	8072 (4.20) 3900 (5.10)	$0.23	$4.49	$4.72
¾	2069 (6.50) 2829 (7.30)	.23	6.96	7.19
1	706 (9.30) 51 (9.12)	.23	9.29	9.52
1½	74 (21.00)	1.40	21.00	22.40
2	47 (35.00) 26 (32.50)	1.40	34.11	35.51
3*	21	.....	60.00	60.00
4*	14	.....	120.00	120.00
6*	3	.....	250.00	250.00

* Set by consumer.

The average cost of testing is as follows: For ⅝- and ¾-in. sizes, 8½c.; for 1-in., 14 c.; for 1½- and 2-in., 47c.; for 3-, 4- and 6-in. meters, $2.10.

Cast-Iron Paving Blocks Along Curb Wear Well Under Heavy Traffic

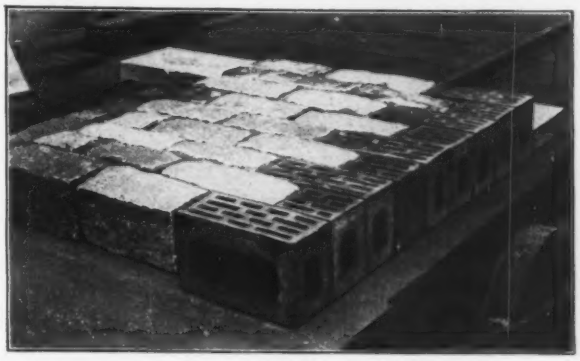
By EDWARD A. BYRNE

Acting Chief Engineer, Department of Plant and Structures, New York City

SPECIAL cast-iron and concrete paving blocks designed by the writer for use along the curbs of bridge approaches, in place of the ordinary granite blocks, have proved satisfactory under service and have fully justified their added initial cost. They were employed in connection with the repaving of the approaches on the Brooklyn Bridge, New York City, referred to on page 306 of this issue, where it was found that the steel-tired vehicles using the curb for a brake on the steep grades of the approaches, concentrated the wear to such an extent that the blocks at this point were destroyed long before the rest of the pavement. The wearing was so irregular and produced such a series of ridges and depressions that vehicle progress was considerably interfered with, and any reasonable speed was impossible. Besides being a great annoyance to the traveling public, these blocks required frequent replacement.

USE OF CURB FOR BRAKE WEARS BLOCKS SEVERELY

The special block is cast hollow, with a top face 1 in. thick, and may be best described as an open box or crate, having ends and faces of ⅝-in.-square metal. The blocks are made in two lengths, 4 in. and 8 in., and are 5 in. deep by 4½ in. wide. Excessive smoothness is avoided by casting recesses in the top face. The hollow space is filled with concrete, which is allowed to set thoroughly before the blocks are placed in position in the pavement.



FILLED WITH CONCRETE, CAST IRON STANDS HARD USAGE

When empty the 4-in. blocks average 8 lb. in weight, and when filled with concrete 12¾ lb. The 8-in. blocks average 13¾ lb. empty and 24 lb. when filled. Laid in conjunction with granite blocks, they increase the cost of a 16-ft. roadway about 10% over the price of a straight granite-block pavement.

Stitch-Riveting of Struts

By ALEX. W. MOSELEY

Lewis Institute, Chicago, Ill.

IN a built-up member, fastenings between the parts are required only at points at which these parts tend to move relatively to each other. The usual practice in designing compression members, however, is to fasten the elements together in such manner as to guard against any increase in the slenderness ratio in any element of the column. Is this safe enough?

Suppose we have a strut made of two 6 x 3½ x ½-in. angles spaced ½ in. apart, of length 96 in. Assuming the two angles to act together, $r = 1.45$ in, and $l/r = 66.2$. The minimum r for this angle (Fig. 1) is 0.67 in.; hence, if we put the pin rivets at the center of length, we have a slenderness ratio of $48 \div 0.76$, or 63.1, which is slightly less than that of the main column.

In Fig. 2 is given an elevation of the column looking at the face of the outstanding legs. Here is shown by means of dotted lines the deflection that the column would probably take if given a load approaching its maximum capacity. There would be no tendency at the middle section for one angle to move axially relatively to the other. The column would act, as far as the deflection

illustrated in Fig. 2 is concerned, as a column of length equal to *twice* the distance between pin rivets. In this case $r = 0.97$ (see Fig. 1). Multiplying 0.97 by 66.2, we have 64.2 as twice the allowable spacing of pin rivets. This calls for connections at each third-point of the length.

With a middle rivet only, the slenderness ratio for parallel axes is 96 ÷ 0.97, or 99. By the A.R.E.A.

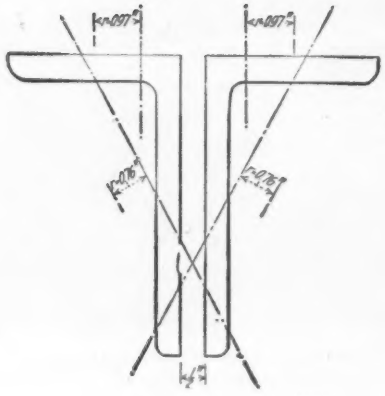


FIG. 1

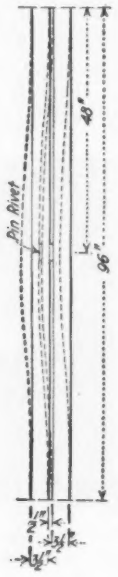


FIG. 2

formula the allowable stress for this ratio is 9070 lb. per sq.in., while the allowable stress for the entire column section, slenderness ratio 66.2, is 11,370 lb. per sq.in. Under the latter load the angles considered as independent elements would be loaded 25.3% over their allowable stress.

Stadia Profile Made with Remarkable Accuracy at Low Cost

By G. W. PICKELS

Associate in Civil Engineering, University of Illinois, Urbana, Ill.

A STADIA profile was run last summer over the Illinois Central R.R. from Champaign to Centralia, Ill., a distance of 125 miles, for the railway-engineering department of the University of Illinois. Top-of-rail elevations were desired at intervals of 300 ft. for use in connection with grade-resistance investigations. The requirements that the stations should be tied-in to the mile posts and that the linear error in any mile should be not more than 10 ft., which is as close as the mile posts can be indicated on the dynamometer-car charts, were easily met.

Using 300-ft. sights, there would be 18 readings to each mile; hence, assuming an accuracy in the stadia readings of 1 in 300, the probable error in the length of a mile, according to the method of least squares, would be $\sqrt{18}$, or 4.35 ft., which is well within the allowable limit of error. This made it possible to use the stadia instead of the usual method of chaining.

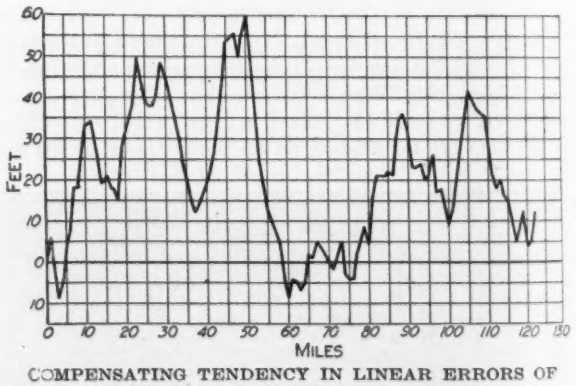
In starting the work the rodman held the rod on the top of the rail opposite a mile post, and this point was recorded as Sta. 0. The levelman then paced a distance of 300 ft. and took a stadia reading with the instrument only approximately level. If the paced distance was within 5 ft. of that indicated by the stadia sight, the instrument was finally leveled, and accurate level and stadia readings were taken. Any error in excess of 5 ft. was corrected by making a new set-up. The rodman then advanced to Sta. 3, approximately opposite the instrument, and a level reading was taken.

The rodman then paced 300 ft. in advance and gave the levelman a trial reading for distance. The levelman signaled the correction necessary to locate Sta. 6, which point was marked on the rail with keel and used as a turning point. The process was repeated at distances of 300 ft. until Sta. 48 was reached. The instrument was set up as nearly midway between Sta. 48 and the mile post as could be determined by eye. Readings to Sta. 48 and to the mile post were made and added to the distance previously covered. In this way the distances between mile posts for 122 of the 125 miles were obtained.

Railroad Distances Assumed To Be Accurate

The distances between mile posts as given on the Illinois Central's official profile were assumed to be correct, and the differences between these distances and those obtained by stadia measurements were considered the errors in the stadia measurements. In very few instances were the mile posts 5280 ft. apart, as indicated by the railroad chaining. The distances between posts varied from 5265 to 5285 ft.; hence, not knowing what reading to expect, the observer was entirely unbiased in taking the last reading in each mile. In every case the stadia measurement was made and recorded before the chained value was taken from the profile.

The maximum error in any one mile was 14 ft. In 7 miles there was no error; in 67% of the miles the error was 5 ft. or less; in 96% it was 10 ft. or less, and the average error per mile was only 4.5 ft.—conforming



COMPENSATING TENDENCY IN LINEAR ERRORS OF STADIA

closely to the probable error of 4.35 ft. expected according to the method of least squares.

As some of the errors were plus and some were minus, the accumulated error at no point was very large. The total error at the end of each mile has been plotted in the accompanying curve, and it is seen (1) that the largest error was 60 ft. at the end of the fiftieth mile, (2) that the error at the end of the one hundred and twenty-second mile was 12 ft., and (3) that at eight points along the line it was zero.

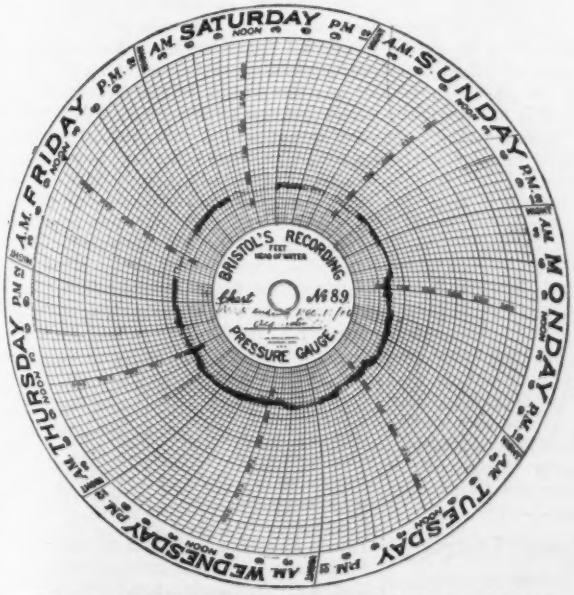
This survey constituted as severe a test of the stadia method of obtaining distances as any of which the writer is aware. The weather conditions were quite unfavorable for stadia measurements, as the work was done on railroad track in July, with the temperature frequently above 100° F. But in spite of these conditions the cost of this survey was about 35% less than it would have been had a third man been added to the party and the distances chained.

As regards the accuracy of the leveling work, it might be added that the United States Geological Survey benchmark at Urbana was used as a starting point and that readings were taken on the United States Geological Survey benchmark at Mattoon, a distance of 43 miles, and on an old Government benchmark at Centralia. The discrepancy at Mattoon was 0.57 ft., and at Centralia 0.37 foot.

The results indicated are sufficiently accurate for most surveys where the data obtained are plotted to a scale of from 100 to 400 ft. to the inch, and the writer believes that the saving in time and money justifies the use of the stadia in a large part of the work that is now done with the tape.

Water Pressure Maintained Constant in Spite of Variations in Draft

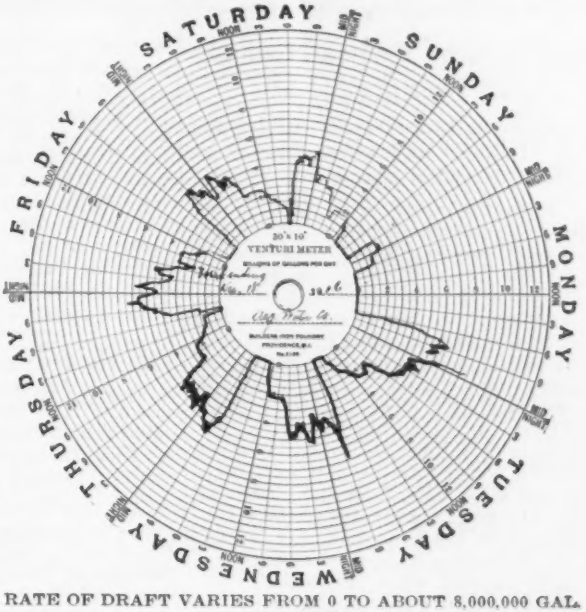
THE accompanying charts, furnished by A. W. Cuddeback, engineer and superintendent of the Passaic Water Co., of Paterson, N. J., indicate how the pressure in the mains of the Passaic water-supply system is maintained nearly constant, in spite of the varying draft, as



REGULATOR VALVE HOLDS PRESSURE CONSTANT

shown in the second chart. The amount delivered varies in rate of draft from nothing to about 8,000,000 gal. per day. As may be seen from the chart, the variations are sudden and irregular.

The Passaic water is taken through a 16-in. Ross regulating valve. The upstream pressure at the connection is about 100 lb. per sq.in.; it is reduced to 30 or 40 pounds. Water passing through the regulator valve is taken from a 51-in. main and delivered to a 30-in. main. The connection was installed in 1908 and, according to Mr.



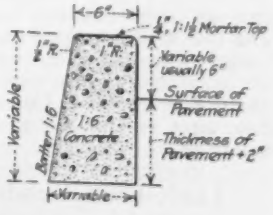
RATE OF DRAFT VARIES FROM 0 TO ABOUT 8,000,000 GAL. PER DAY

Cuddeback, has been operated continuously and satisfactorily since that time.

Builds Monolithic Curb with Integral Asphalt Expansion Joints

By E. E. KIRKPATRICK
City Engineer, Bartlesville, Okla.

BETTER quality of work, better and more positive expansion joints, less risk in construction, better protection against drying, elimination of the danger of mortar scaling, elimination of the damage caused by removing templets and forms while the work is green, and a better top facing owing to the fact that it is placed immediately after the body concrete has been deposited, are the advantages derived from the new specification for concrete curbs recently adopted by Bartlesville, Oklahoma. The curb, of the dimensions shown in the illustration, is blocked off into sections not exceeding 7 ft. in length by transverse expansion strips not less than $\frac{3}{32}$ in. nor more than $\frac{3}{16}$ in. in thickness. These strips, placed before the concrete is deposited, are composed of asphalt-roofing sheets, asphaltic felt or other elastic asphaltic material cut to the form of the cross-section of the curb.



The concrete is spaded thoroughly, the expansion strips being held in place by thin boards or metal strips that are raised as the concreting progresses. The mortar top dressing is placed as soon as the form is filled. Dressed lumber is used for forms, and the concrete is mixed to such consistency that with proper spading a perfect face is obtained.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

Contractors Respond Quickly to Emergency Call

Inquiry to List Firms Available for Urgent Construction Meets Wide Approval

Scores of replies received by return mail to the announcement last week that "Engineering News-Record" would list the resources of contractors for the use of the Government indicate that everyone is anxious to see the conduct of the war as it affects construction adjusted to handle the necessary emergency work without disturbing equally necessary work already under way.

Every firm that has replied has expressed a willingness to do anything needed which it is able to undertake. At the same time, from many parts of the country come reports of the condition which the editors of this journal had foreseen—contractors already engaged on work which demands all their resources, and which ought not to be interrupted.

A number of local organizations and one national society of contractors have already undertaken as a result of the inquiry to compile the resources of their membership. It seems already assured that the information tabulated from these replies will enable the proper authorities to secure the services of experienced contractors for any work likely to be needed in any part of the country without seriously disturbing construction now under way.

Few Bidders on Government Contracts

Some recent Treasury Department contracts have awakened very little competition among contractors. In the case of a $100,000 building at Chattanooga only one bid was received, and this same condition obtains in the case of a postoffice at Commerce, Tex. On other jobs in the past few weeks the usual number of bidders has been two, three or four and rarely as high as six.

Limit Road Building to Military Needs

More than $2,500,000 has been cut from the appropriations for special road building by the California Senate Finance Committee. In lieu there will be a blanket appropriation of $250,000 to be used in the Federal Government scheme for military road construction approved by the War Department.

No other road appropriations will be made at this session of the legislature, and only such roads as are definitely laid down as of military importance and necessity will be built during the coming two years. This does not apply, however, to the state highway construction, which will go forward out of the proceeds of the sale of $15,000,000 bonds voted at the last general election. Austin B. Fletcher, State Highway Engineer, reported upon the entire plan of Federal military road building. He said that it was the purpose of the Government not to construct a road along the coast, but to build it 50 miles inside of the coast line and then to work the roads back from the coast to interior points for military movement.

Rush Work on New Town for 55,000 War Workers

Bethlehem Steel Builds Complete City, Including Water Works, Sewers and Streets

The tremendous industrial development taking place at Sparrows Point, forced by the munition and related war business of the Bethlehem Steel Co., has resulted in the laying out of a city for 55,000 people. By the time cold weather sets in this year, five hundred residences will have been constructed and the business blocks and public buildings, called for by a town of this size, will have been located. This involves the complete design and construction of the water supply, sewerage, grading and paving. The water supply will be taken from artesian wells and the water will be raised to the surface by means of compressed air. The water will be pure from a sanitary standpoint, but it is filled with iron and it will be necessary to construct an iron remover plant for the treatment of the water.

The proposition is unique in that the town will be built in the open country, and it will be possible to use methods of construction and effect economies which could not possibly be carried out in the ordinary water works or sewerage construction. Not only the trenches for the mains, but also the trenches for the house connections will be dug with trenching machines, and the back filling will all be done with back filling machines. The engineering work is being done by Norton, Bird & Whitman, of Chicago and Baltimore.

To Protect Pittsburgh Districts from Floods

A bill appropriating $25,000 to the Pennsylvania Water-Supply Commission, to enable it to coöperate with the Federal Government in preparing plans to prevent floods at Pittsburgh, was introduced on Apr. 9 by Representative W. J. McCaig. The Government already had set aside a similar amount to cover the cost of drawing plans of protection works at the headwaters of the Allegheny and Monongahela Rivers.

Divided Report of Experts On Canadian Railways

Both Public Board of Trustees and Continued Private Management Advocated

Two radically different reports were presented last week by the Royal Commission created to inquire into Canada's complex railway problems. The majority report, signed by Sir Henry L. Drayton and W. W. Acworth, advocate turning the Grand Trunk, Grand Trunk Pacific, Canadian Northern, National Transcontinental and Intercolonial over to a board of five public trustees. A. H. Smith, president of the New York Central R.R., in the minority report, favors continuation of the present private control of the first-three-named systems, but redivided along geographical lines to minimize competition. Both reports are agreed as to the extravagance of the Dominion's railroad construction of the last decade, and as to the folly of permitting the extensive further construction that would be necessary to give Canada three properly developed transcontinental lines. Both are agreed, also, as to the general undesirability of government operation of railroads.

The report is the outcome of Canada's period of what is generally conceded now to have been extravagant railroad construction, the climax of which was reached three years ago, when the Grand Trunk refused to take over the new government-built National Transcontinental Ry. and an investigation disclosed the excessively high cost of that road. Briefly, the privately owned Canadian Pacific had proved a financial success, but the other privately owned systems were in distress and the government owned lines were failing utterly to meet expenses—and the commission was created to seek a remedy.

Majority Plan

The remedy proposed by Sir Henry Drayton and Mr. Acworth is the creation by act of Parliament of a board of trustees to be incorporated as the Dominion Railway Co. They would take over the stock of the Canadian Northern, Grand Trunk and Grand Trunk Pacific, and would operate these roads, as well as the government owned National Transcontinental and Intercolonial railways as one united system. The board would be permanent and self-perpetuating. The trustees would be appointed for seven-year terms and would be eligible for renomination and reappointment. Three of them would be railway men, a fourth would be "selected on the ground of business and financial experience," and the fifth "as specially possessing the confidence of railway employees."

The bonds and other obligations of the privately owned roads would remain undisturbed. An arbitration board would determine what proportion of the Canadian Northern common stock might remain the property of the present holders and what proportion of the earnings of the Dominion Railway Co. might be regarded as attributable to the Canadian Northern line. As to the Grand Trunk stockholders, the commission would take care of them by the payment of an annuity to the company as a whole, its directors to determine upon the division of the annuity among the various classes of shareholders.

It is felt that a board of trustees constituted as above outlined would be nonpolitical. The Board of Railway Commissioners, however, would have the same judicial authority over all its actions as over the private railway companies.

Mr. Smith's Plan

Mr. Smith's view is that the above plan is virtually government operation, which the majority members admit is in general objectionable. He agrees with the majority members that the Grand Trunk is strong in the East and weak in the West, that the reverse is true with the Canadian Northern, that each would have to build extensively into the territory of the other to make it a successful competitor with the other and with the Canadian Pacific, and that this would result in wasteful duplication. He feels, however, that the private companies should be allowed and required to work out their own salvation, and that this can be accomplished without wastefu' construction by assigning to each of the two principal companies the territory in which it is strongest. Thus he would give the Grand Trunk eastern Canada and have it lease the lines of the Canadian Northern in that section, while he would give the Canadian Northern the territory west of Winnipeg and have it lease the Grand Trunk Pacific. The intervening link between North Bay and Winnipeg could be leased to either company or to a new company. He would have the Grand Trunk released from all obligations with respect to the National Transcontinental.

Mr. Smith's recommendations, he states, are made with a view to obtaining for Canada a maximum of efficiency at a minimum outlay. He holds that the continuance of government aid, to some of the railroads, at least, will be necessary under any plan, and that this plan seeks to reduce it to the lowest possible point.

American Engineers Named To Aid Russia's Railways

A special commission of eminent railroad engineers will be sent to Russia immediately by President Wilson to help reconstruct that nation's transportation system. It will be made up of four men, including John F. Stevens, of New York; John E. Greiner, of Baltimore, consulting engineer, and Henry Miller, former president of the Wabash.

Mr. Stevens had been named as a member of the commission to be headed by former Secretary Root, but at the request of members of the National Defense Council, the President released him to serve on the special railroad mission.

Engineer Regiments Will Sail to France

Will Engage in Railroad Work on Lines of Communication—Recruiting Office for New York Unit Is Opened

Within three months at the latest United States engineer troops will have begun the work of building railroads on lines of communication in France. In orders issued this week the War Department has called for the raising of nine engineer regiments—about 10,000 men in all—under the terms of National Defense act of June 3, 1916, which prescribed that in time of war the army might be provided with such additional units of a special character as were required, in addition to the establishment of fighting men provided by law. The men to be enlisted will not be drafted. They will be volunteers, and appeal is being made for those who have had railway, bridge-building, subway, or other engineering experience in similar or related lines.

Recruiting Points

The recruiting points for the new engineer troops, according to the War Department's announcement will be at New York City, St. Louis, Chicago, Boston, Pittsburgh, Detroit, Atlanta, San Francisco and Philadelphia. This week the first recruiting office for the regiment which will represent the Metropolitan District was opened at 190 Sixth Ave., New York City. Men who volunteer for service in these engineer units, according to Col. C. H. McKinstry, who will command the New York regiment, will not be subject to draft or transfer to other organizations in case the conscription measures now pending in Congress become law.

Enlistment is for the term of the war only.

Regulars in Command

The names of the officers who will command the nine engineer regiments are as follows: New York district, Col. C. H. McKinstry; St. Louis, Col. C. McD. Townsend; Chicago, Col. W. C. Langfitt; Boston, Col. W. P. Wooten; Pittsburgh, Col. Edgar Jadwin; Detroit and Cleveland, Col. Harry Burgess; Atlanta, Birmingham and the South, Col. John S. Sewell; San Francisco, Col. James B. Cavanaugh; Philadelphia, Col. Herbert Deakyne.

According to information received by "Engineering News-Record" from Washington, the Boston, Chicago and St. Louis regiments will be used exclusively on the operation of railways behind the European battle lines while the six other units will be assigned to duties principally of railway maintenance and construction.

Official Announcement

The official announcement of the plan was given out as follows:

"The War Department has sent out orders for the raising as rapidly as possible of nine additional regiments of engineers, who are destined to proceed to France at the earliest possible moment for railroad work on the lines of communications.

"It is requested of the press that no speculations or rumors regarding this force be carried by them, other than those given out by the War Department. All details with regard to the

New York Central May Bridge Hudson Below Albany

Permission has been granted the New York Central R.R. by the U. S. War Department to bridge the Hudson River 11 miles south of Albany, in connection with the proposed high-lever detour connecting the New York Central main line, the West Shore R.R., and the Boston & Albany R.R. (see the "Engineering Record" of Feb. 24, p. 312). The company desired to build the bridge with a main span over the present channel of 600 ft. and a second span to the east of 405 ft. The city of Albany and other interests in that vicinity opposed the placing of the intermediate pier on the ground that it would obstruct and be a menace to navigation, and sought to have the company compelled to put in a 1000-ft. span. The objections were over-ruled.

The bridge will give a vertical clearance of 139 ft., the rails being at El. 148.2. With a long viaduct approach at the east end and a shorter one at the west, the total length of the structure will be about 5100 feet.

Contractors Advised To Wait for Army-Camp Locations

The War Department has not yet definitely selected the sites of the training camps at which new troops will be concentrated, so that contractors willing to undertake work on the cantonments are advised to wait patiently for further announcement before applying for plans and specifications. Otherwise, contractors would be figuring on work finally located where they could not handle it. Moreover, the Engineer Corps personnel is already overworked and cannot attend to advance requests. It is expected that the preliminary details will be completed in a short time.

force will be released by the department as fast as compatible with the public interest.

"Two officers from the regular Corps of Engineers will be assigned to each regiment, but the names of these officers will not be released at the present time."

Officers Named

The formation of the units is the result of conferences between American military officials and the members of the British and French war missions.

The regiment to be sent from New York will be designated the First Reserve Engineers. On May 2 the War Department issued orders directing commissioned officers of the Engineer Officers' Reserve Corps who had been assigned to the First Reserve Engineers, to report in person to Lieut. Col. Charles H. McKinstry, Corps of Engineers, Army Building, New York, for duty in connection with the recruiting of men in the engineers' enlisted reserve corps and the organization to be known as the First Reserve Engineers of New York City. These officers are:

Majors William Barclay Parsons and Arthur S. Dwight; Captains George H. Gifford, Harold W. Hudson, John P. Hogan and John D. Irving; First Lieutenants Joseph M. Marshall, Jr., Edward K. Carley, and Clifton W. Wilder, and Second Lieutenants Frederick W. Toerner and Charles M. Anderson.

Commanders for the other new regiments probably will be announced tomorrow. Work of recruiting the regiments will start immediately, and as each recruiting center is a city where there is an army post, it is assumed the regiments will be assembled in army barracks and their organizations perfected.

Cleveland Refuses Contract to Defaulting Companies

Until certain paving contractors have complied with their maintenance contracts on about 50 streets paved with asphalt, the Cleveland Board of Public Works will refuse to award them any further contracts. Furthermore, no tax bills will be issued on contracts the defaulting companies have under way, until the maintenance has been brought up to date. Two companies were given one week to comply with their maintenance obligations, while a third company was given but three days' grace.

Cleveland Urges Use of Canals

Feeling that the insufficiency of means for freight transportation is a question of national concern and that the canals of Ohio are not now being used as they might be, the Cleveland City Council, on Apr. 25, requested the governor to have a special study made immediately of the canals. The idea is to determine the feasibility and economy of placing the canals in usable condition.

International Power Development Proposed for St. Lawrence River

Coöperation between the American and Canadian Federal Governments for the concentration of falls along the St. Lawrence River and the development of huge power stations was proposed by C. R. Coutlee, of the Department of Public Works, Ottawa, in a paper recently presented before the Ottawa branch of the Canadian Society of Civil Engineers.

The river is at present an international highway under the jurisdiction of a joint commission, but between Niagara and Montreal the transportation tonnage is comparatively small, and the development of power along this stretch is becoming the dominant interest. About 500,000 hp. is now produced here, and nearly 7,000,000 hp. is possible of development. The proposed concentration of falls along this waterway is as follows:

	Hp.
1. Soo	80,000
2. Detroit regulation dam and lock	30,000
3. Niagara and other passes	2,000,000
4. Whirlpool	2,000,000
5. Iroquois	290,000
6. Morrisburg	190,000
7. Cornwall	700,000
8. Coteau Fort	255,000
9. Cedars	500,000
10. Cascades	190,000
11. Lachine	380,000
12. Montreal	315,000
	6,930,000

Where power is already being generated, the Government would purchase the works and increase the development. A similar concentration of falls on the Ottawa River was proposed, to yield 1,570,000 hp.; but this would not be under international control. The cost would be $500,000,000 for the work on the St. Lawrence and $100,000,000 for the Ottawa River.

To improve the ship channel from Montreal to the sea, a rock-fill dam was proposed to be placed at Tadoussac, 100 miles below Quebec. Here would be a twin lock of Panama Canal size with pond surface slightly above high-tide level and controlled by regulation sluiceways to give proper discharge between tides without creating currents of more than 3 miles per hour. This would give a 40-ft. depth of the channel to Montreal. On account of the slack water the ice could be broken up in March, so that the port would be open a month earlier than at present.

Arizona Considering Contract System for State Work

Arizona will vote at the next general election on the question of restoring the contract system on state construction work. The Industrial Pursuits act, of 1914, abolished the contract system. A bill has been passed in the legislature providing for the amendment of the act by striking out sections prohibiting contract labor. The governor has signed this bill, which, as it pertains to an act adopted by the people, must be referred to the electors and approved by them before becoming effective.

Los Angeles To Purchase Distributing System

Power Companies Will Be Distributing Agents of the City Until Details of Purchase Are Settled

The City Council of Los Angeles has approved the revised draft of the contract covering the city's purchase of the distributing systems of the Southern California Edison and Pacific Light and Power companies. The plan approved carries with it an agreement whereby the companies will distribute power from municipal plants in conjunction with that from their own sources until such time as the city takes over the properties.

The terms of the agreement are that the city will buy the desired portions of the two distributing systems for $8,270,000 plus $1,145,000 for severance damage. The temporary agreement provides that in addition to the city's power the companies will furnish such additional power as may be required by the territory served, such additional power, however, not to be less than 25,000 horsepower.

What Companies Will Do

The companies agree to maintain the systems, make extensions and improvements, collect from the consumers as the city's agents, and to appoint two members of a board of supervision, two other members of such board to be appointed by the city. This board shall determine the policy and decide questions governing the maintenance and extension of systems and the management of the business in general.

The financial terms of the temporary agreement are that the companies will retain from consumer's collections 8% per annum on the $8,270,000 purchase price and 6% on $130,000 as part of the severance damage effected by the contract. The actual cost of the power furnished by the companies is to be held as a trust fund and turned over to the city when the properties are taken over. The remainder of the collections from consumers is to go to the city as its share of the business. The agreement is to go into effect subject to the approval of the State Railroad Commission.

President Betkouski, of the City Council, announced that it is intended to submit the proposed $12,000,000 power bond issue to the people at an early date. Councilmen and members of the special power committee stated that they were confident that the success of the power negotiations is now finally assured.

Iowa Senate Kills License Bill

The bill to license civil engineers in Iowa was defeated in the state Senate last month. The bill was complicated at the last minute by the addition of an architect's clause. There were 18 yeas and 22 nays, while 10 senators failed to vote.

Sewage-Treatment for Erie Would Cost $810,000

Intercepting sewers, grit chambers, screens, Imhoff tanks, and an outfall sewer discharging into Lake Erie at a depth of 26 ft., are recommended in a report just made by Gannett, Seelye & Fleming, consulting engineers, Harrisburg, Penn. The treatment plant would have a daily capacity of 20,000,000 gal., which is the present normal dry-weather flow, and would cost about $335,000. By separating storm water such a plant would keep pace with population growth and would serve for some years to come. The report outlines sewage-disposal needs up to 1950, including considerable area now outside the city. The population to be cared for in 1950 is estimated at 340,000.

Principles of Conduct Outlined for University Students

The faculty of the Towne Scientific School of the University of Pennsylvania has issued to the students a short list of principles, which it believes are essential to the highest usefulness of the students in military, technical or industrial service. It is recognized that these principles are subject to change through enactment of legislation for universal military service, selective conscription or other military or preparedness measures. These principles, as outlined by Prof. Edgar Marburg, are as follows:

(1) That they enroll for military preparedness drill at the University.

(2) That men in the early stages of their undergraduate course, who have had experience in farm work, should volunteer without delay for service in a prospective national agricultural movement, with the expectation of holding themselves in readiness for active agricultural service promptly on call.

(3) That other undergraduates should defer volunteering for any particular branch of the public service, pending further developments—concerning which they will be promptly informed through University sources—as to the particular channel or channels in which their services are likely to be of the greatest value to our country.

(4) That the members of the senior class contemplating employment to be entered upon after graduation, be governed insofar as possible by the prospective value of such industrial service to the country in war.

Upper Court Rejects Patent on Concrete Floor System

A decision rendered Mar. 12, 1917, by the U. S. Circuit Court of Appeals for the Eighth Circuit, Justices Sanborn, Hook and Amidon sitting, upheld the decision of the lower court dismissing a complaint for infringement of U. S. Patent No. 633,285, made by the Corrugated Bar Co. against the Trussed Concrete Steel Co. et al. The patent, issued to A. L. Johnson, Sept. 19, 1899, is for an improvement in fireproof floor construction consisting principally in the use of transversely corrugated bars as tension reinforcement for concrete slabs or for concrete floor-beams, and in the use of loops of wire suspended from such bars and projecting below the concrete for the purpose of hanging a ceiling below the floor.

Ruling on Bar Corrugations

The decision is of importance in that it maintains that claims for a corrugated bar could not be considered original simply because of the novelty of the corrugation, no matter how specific those corrugations might be devised. The decision in effect states that protuberances on all previous bars were there to increase bond; that it does not require the genius of an inventor to perceive and to apply the knowledge that corrugations of a given size, arranged substantially perpendicular to the axis of a bar, will accomplish the object of preventing its slipping more effectually than when they are inclined more nearly to the horizontal. Such knowledge and its application fall far within the attainments of a mechanic skilled in the art if not within the attainments of men of still less skill and mechanical information. The decision goes on to state that the previous inventions and patents invalidate the projecting hanging loops to which a ceiling may be attached. It repeats that this part of the patent can be legally attributed to nothing but the skill of the ordinary mechanic.

Rebuilding a Missouri River Bridge

Building new piers, shifting old spans upon them and building a new drawspan is the work involved in the reconstruction of the St. Joseph & Grand Ry. bridge over the Missouri River at St. Joseph, Mo. This is a single-track bridge with a roadway carried on brackets outside of the trusses. It has three pin-connected spans 297½ ft. and 295½ ft. long, which will be shifted endwise about 137 ft. to rest on the new piers. There will be a new drawspan, 465 ft. long, and two deck-girder spans 60 ft. and 81 ft. long.

The new substructure includes six concrete piers, on foundations sunk by the pneumatic process to reach rock at 52 ft. below low water. At the east side are one pier and an abutment founded on piles. On account of the bend in the river at this point the channel is on the east side, and the current there (under the drawspan) is very swift, running as high as 9 miles per hour at times. Work under compressed air is now in progress on the first pier (No. 5).

The bridge was designed by R. L. Huntley, chief engineer of the Union Pacific System. The new drawspan will be built by the American Bridge Co. The substructure work is in the hands of the Missouri Valley Bridge and Iron Co., Leavenworth, Kansas.

Commission Government Voted at Charlotte, N. C.

After a four years' campaign the voters of Charlotte, N. C., on Apr. 23 adopted the commission plan of government with a single commission of three in place of a dual government consisting of a Board of Aldermen of 21 members and an Executive Board of five. There will be Departments of Finance (the Mayor, at $3500 a year), Safety and Works (each at $3200 a year). The Commissioner of Public Works will have charge of streets, public buildings, plumbing, electrical and building inspection.

Recent Kansas Road Law Gets a New Interpretation

The recent Kansas legislation, noted in *Engineering News-Record*, Apr. 26, p. 203, which seemed to make comparatively simple the rapid extension of the state highway system, has recently been interpreted by the attorney general in such a way as to render invalid those sections which seemed to hold out the most promise. The law, as ordinarily understood, permitted resident property owners in a county to define by petition a benefit district, the width of pavement and the type of surfacing desired. If this petition were signed by 35% of the resident land owners owning 51% of the acreage, or by 51% of the residents owning 35% of the land, or by owners of 60% of the land in the benefit district regardless of number of residents, then the county commissioners were obliged to order the improvement. The recent interpretation states that it is entirely discretionary with the county commissioners whether they pay any attention to the petitions or not, and that there is nothing in the law which says that the county commissioners must act upon the petitions.

Water Rates Reduced To Increase Irrigated Areas

The State Railroad Commission of California has authorized all public utility water companies in that state to deliver their surplus water at reduced rates and in some cases free, for the irrigation of additional lands during the emergency created by the war. To protect their legal rights, the water companies may require users of this surplus water to sign agreements that the service is for the war emergency only, the companies to deliver this emergency water as long as the crops for which the water is requested require irrigation, but in no event for more than six months after the close of the war. This order followed a public investigation which the commission undertook on its own motion on the effect of water rates on possible food production during the war.

Personal Notes

W. C. Woodland, chief engineer of the Packard Electric Co., Warren, Ohio, has resigned to enter the employ of the Steere Engineering Co., Detroit, as consulting engineer.

James B. Abbott, Jr., who has been engaged recently in installing water mains in various cities in the South, has become associated with Robert L. Totten, civil engineer, Birmingham, Alabama.

J. B. Hutchinson, Jr., has been advanced from division engineer of the Pittsburgh division of the Pennsylvania R.R. to the position of assistant superintendent of the same division.

J. O. Hackenberg, now supervisor of the Pittsburgh division of the Pennsylvania R.R., at East Liberty, Penn., has been made division engineer of the Allegheny division.

C. H. Buford, engineer of track elevation of the Chicago, Milwaukee & St. Paul Ry. at Chicago, has been appointed trainmaster on the Sioux City and Dakota division, with headquarters at Sioux City, Iowa.

A. T. Mercier, division engineer of the Southern Pacific Co. at Los Angeles, has been appointed assistant superintendent. He will be located at Dunsmuir, Calif., succeeding G. V. Gillette.

A. J. Smith, roadmaster of the Lake Erie & Western R.R. at Tipton, Ind., has been appointed division superintendent at Muncie, Ind., succeeding J. W. O'Brien.

W. S. Campbell has been made manager and chief engineer of the Kentucky & Indiana Terminal R.R., with headquarters at Louisville, Ky. He succeeds J. H. Rightmeyer.

H. M. Hobson has been transferred from the Valley to the Arkansas division of the Missouri Pacific Ry., as assistant engineer, at Little Rock, Arkansas.

B. C. Milbrath, formerly superintendent of road construction for F. G. & A. C. Proudfoot at Daytona, Fla., is now in the employ of H. J. Carr & Co., general contractors and engineers, at Augusta, Ga., as superintendent on reinforced-concrete construction work in that city.

Paul P. Whitham, consulting engineer, formerly chief engineer of the Port of Seattle Commission, has discontinued his office in the New York Block, Seattle, Wash. He expects to be absent for some time in the Orient as consulting engineer and trade commissioner for the United States Department of Commerce.

E. L. Grimes is now located at 503 National State Bank Building, Troy, N. Y., where he will practice as a consulting civil engineer, giving special attention to water-supply matters, filtration plants, water-power developments, sewerage, sewage disposal, as well as railroad construction, bridge and road-building and paving work.

H. P. Eilers, formerly with Manning, Maxwell & Moore, Inc., has opened an office in the Singer Building, New York City, where he will handle machine tools for domestic and export trade.

George T. Hand, whose appointment as chief engineer of the Lehigh Valley R.R. was briefly noted last week, is by the appointment returning to the railroad with which he started. Born at Elizabeth, N. J., his first railroad work was as a rodman with the National Docks Ry., now a part of the system. Later he was principal assistant engineer and assisted in the construction of the piers, warehouses and other parts of the Lehigh Valley's Jersey City terminals at National Docks. Going to the Delaware, Lackawanna & Western R.R., he was successively assistant engineer, terminal engineer and division engineer. In these capacities he had to do with the construction of the passenger and freight terminals at Hoboken. In addition to this Mr. Hand has done much consulting work.

New Chief Engineer of the Lehigh Valley

GEORGE T. HAND

E. B. Ashby, chief engineer of the Lehigh Valley R.R. for the last nine years, has been appointed consulting engineer. Mr. Ashby was graduated from Rensselaer Polytechnic Institute in 1886. The same year he entered the service of the Pennsylvania R.R., with which he remained until 1897. In that year he went to the Baltimore & Ohio R.R. as principal assistant engineer maintenance-of-way. Two years later he came to the Lehigh Valley as assistant engineer maintenance-of-way. The next year he was promoted to engineer maintenance-of-way, and in 1908 was made chief engineer.

E. J. Dent, major, Corps of Engineers, United States Army, until recently in charge of the Government work on the Arkansas, White and St. Francis Rivers, with headquarters at Little Rock, Ark., has been relieved there by Lieut. Col. George P. Howell, Corps of Engineers. Major Dent is now stationed at Portland, Ore., in charge of the Cascade locks and canal, The Dalles-Celilo canal and open river work on the Columbia River between Vancouver, Washington, and Lewiston, Idaho.

George Houston has resigned as city water commissioner of Kalamazoo, Mich., after having served in that capacity for 15 years.

Warren Stoutnour, engineer, Salt Lake City, Utah, has been appointed a member of the State Public Utilities Commission of Utah, which has been created by a law recently enacted. Since 1912 he has been employed by the Salt Lake & Ogden R.R. Co., which position he held at the time of his appointment on the commission.

L. C. Torrence, Grenada, Miss., has been appointed highway engineer for road district No. 2, St. Francis County, Arkansas.

W. R. Caldwell, formerly city engineer of Traverse City, Mich., has been appointed city engineer of Ypsilanti, Mich., to succeed R. D. Goodrich.

D. J. Blackmore, administrative superintendent of Cincinnati, Ohio, has resigned his position to go into the auto-truck business.

E. H. Baldwin has resigned as senior engineer of the United States Reclamation Service to take a position with the Guggenheim Bros., New York City, as chief of field forces of their construction department in South America. Mr. Baldwin has been in the Reclamation Service since 1905, during which time he had charge of important construction work, including the Pathfinder and Elephant Butte storage dams. Prior to his entering the Reclamation Service, he was for 10 years connected with the Metropolitan Water Board of Boston, Massachusetts.

William W. Sime has resigned as advertising sales manager of the Patton Paint Co., Milwaukee and Pittsburgh, to become manager of the trip-hammer department of the Keller Pneumatic Tool Co., Fond du Lac, Wis., which is now building and equipping a new plant at Grand Haven, Michigan.

Maxwell C. Maxwell, formerly superintendent of power and plant and of the tool-machine departments of the Yale & Towne Manufacturing Co., Stamford, Conn., has been made assistant general superintendent of the company. **A. O. Blackman** has been appointed superintendent of power and plant, and **J. B. Freysinger** superintendent of the tool and machine department.

John T. Mockler, formerly assistant engineer in the New York State Engineer's Department on Barge Canal

work, and more recently connected with the New York State Highway Department, has been appointed assistant engineer in the City Engineer's Office at Buffalo, New York.

E. C. Eaton, who designed and constructed the auxiliary water-supply system for the Panama-Pacific Exposition, and as superintendent operated the system during the exposition, has recently been appointed resident engineer of the Lindsay-Strathmore Irrigation District, a $1,500,000 water-supply system now being constructed in California.

M. W. Watson has resigned as assistant road engineer of the Illinois State Highway Department, to become road engineer with the Kansas State Highway Commission. Previous to his employment with the Illinois Highway Department, he served with the United States Engineers' Office at Louisville, Ky., on the Ohio River improvement and on various engineering work in Ohio, West Virginia, Indiana and Kentucky.

Obituary

Willard B. Hastings, an engineer identified for almost a quarter century with the development of Alaska, died recently at Anchorage, from pneumonia. He had been in the employ of the Alaska Engineering Commission since last July on the government railway project. Mr. Hastings was born in Hillsdale, Mich., in 1855. During his residence in Alaska he was stationed at various times at Unalaska, Unga, St. Michael, Nome and Seward. At Unalaska he served as deputy United States marshal.

Thomas F. Cunningham, head of the contracting firms of Cunningham & Murray, the Philadelphia Paving Co. and the Cunningham Paving and Construction Co., died at his home in Merion, Penn., on Apr. 28, at 75 years of age.

George W. Williamson, formerly a member of the firm of Williamson Brothers & Co., afterward consolidated, with other concerns, as the American Engineering Co., died, on Apr. 30, at his home in Philadelphia. He was 67 years old.

James W. Patterson, Jr., contractor, formerly superintendent of the Wabash-Pittsburgh Terminal R.R., died, on May 1, at his home in New York City. He was born on the Southside, Pittsburgh. He started his career as an engineer, practising under his father, James W. Patterson, Sr. His first employment was with the Wabash R.R. Later he was identified with the El Paso & Mexican Northern R.R. In 1897 he became division engineer of the Wabash at Peru, Ind., and was with the middle division until 1901, when he went to the Wabash-Pittsburgh terminal as engineer of construction. He was appointed superintendent in 1904 and a year later resigned to enter the contracting field.

Mark Lowd, southwestern manager of the Stone & Webster Engineering Corporation, died at his home in Dallas, Tex., on Apr. 27. He was born in Salem, Mass., in 1879. In 1902 he acted for Stone & Webster as chief engineer and superintendent of construction of the Seattle (Wash.), Electric Co., and in 1907 was made southwestern manager at Dallas.

Frederic Anton Eilers, a pioneer American mining engineer and metallurgist, died at Sea Cliff, N. Y., on Apr. 21, at the age of 78. He first became conspicuous about 1878 for his improvements in smelting practice in Utah and Colorado. In 1883 he demonstrated at Pueblo the advantages of combining ores from distant mines at a central smelter. When the American Smelting and Refining Co. was organized in 1899, he became a director. He was one of the oldest members of the American Institute of Mining Engineering and had been a manager and vice-president.

D. J. MacDonald, a former railway contractor, died at Chicago, on Apr. 27, at 65 years of age.

Albert S. Glover, secretary of the Hersey Manufacturing Co., Boston, Mass.. died suddenly in that city on Apr. 23. Mr. Glover was widely known in the water-works field. He attended the Massachusetts Institute of Technology and at a later period was for ten years water registrar of the City of Newton, Mass. At one time he was employed in the water department of the City of Boston and afterward became connected with the Hersey company. He was 63 years of age.

Frederick T. Elwood, city engineer of Rochester, N. Y., died at his home in that city, on Apr. 22, after an illness of three years. Mr. Elwood was born in Rochester and received his education in the old Rochester Free Academy and the University of Rochester. He spent several years in the West, associated with H. H. Warner, the English engineer, in the development of Western mining properties. On his return to Rochester, he was appointed transitman in the office of the city engineer, later becoming assistant city engineer. He was afterward transferred to the office of former Mayor James G. Cutler as confidential clerk, and was appointed commissioner of public works in 1906. In 1912 Mr. Elwood was made deputy city engineer, receiving his appointment as city engineer in March, 1915.

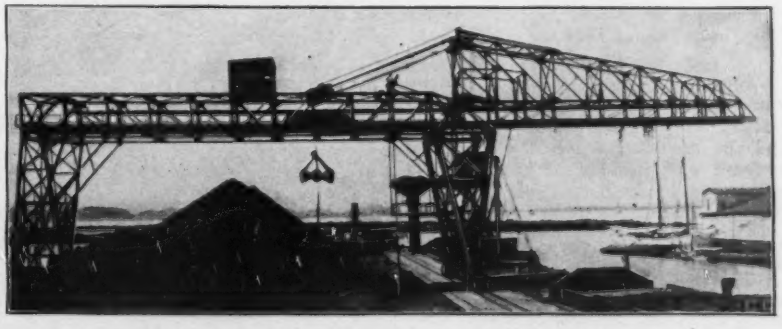
Theodore Vandivort, civil engineer, New Castle, Penn., died at his home in that city on Apr. 16. He was born in Mahoningtown, Penn., 68 years ago. Mr. Vandivort began his business career as a rodman with the Erie & Pittsburgh R.R. in 1869. In 1872 he was appointed assistant engineer of the New Castle & Franklin R.R., and five years later entered the service of the Pittsburgh & Lake Erie R.R. and assisted in locating and constructing the road between Pittsburgh and Youngstown, Ohio. He became an employee of the Pennsylvania R.R. in 1884 and remained with that company 30 years.

Appliances and Materials

Porto Rico Gantry Has Unusual Features

The coal-handling gantry illustrated herewith, recently installed in San Juan, Porto Rico, by the Cleveland Crane and Engineering Co., has a hinged cantilever boom, all truck and trolley wheels geared as drivers, automatic rail-clamping devices, and regenerative braking of the hoist motors when the load is descending.

The gantry span is 127 ft., and the cantilever is 95 ft. To withstand West Indian hurricanes, the structure was designed for a wind load of 50 lb. per sq.ft. exposed area. The trolley track is 48 ft. above the dock level and has 8-ft. gage. The maximum trolley-wheel load is 10,000 lb. The maximum trolley speed is 800 ft. per min., and that of the bucket hoist 300 ft. per min. With a 3½-yd. clamshell bucket delivering coal from boats to the center of the span,



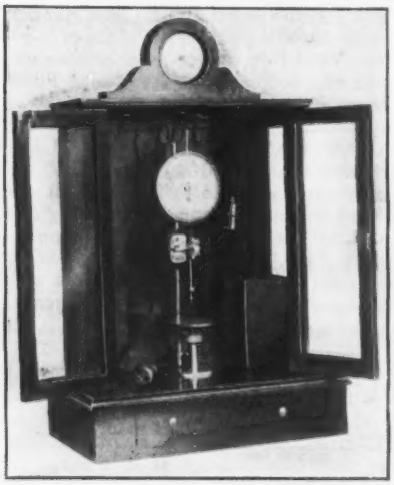
DESIGNED FOR TROLLEY WHEEL LOAD OF 5 TONS AND WIND PRESSURE OF 50 POUNDS PER SQUARE FOOT

the capacity is 180 tons per hour. A 12-ton suspended hopper has two swinging spouts for loading railway cars; a portable hopper with telescope spout can be rigged on the cantilever for connection to fueling chutes of boats.

The main trucks (four wheels) have a 12-ft. wheelbase and are 40 ft. c. to c. Two motors traverse the gantry, one truck on each leg being driven by one motor. All motors are for 60-cycle three-phase 440-volt current. Power is taken to the trolley by angle conductor tracks with under-running contact shoes. The control gage is under the cantilever hinge.

New Penetrometer Eliminates Test Variations

The Hoyt penetrometer, shown in the accompanying view, is a new instrument for making penetration tests on viscous materials, such as asphalts and tars. The sample is placed on the disk, which is then raised by a screw to bring



THIS PENETROMETER ELIMINATES THE PERSONAL EQUATION

the sample in contact with the weighted needle. This needle is released by pressing a button, and after five seconds (or any predetermined time) it is clamped automatically. The depth of penetration is indicated on the lower dial. Any desired weight can be applied to the needle, and the time of test (except for the standard five-second period) is adjusted by setting the hand of the top dial. The mechanism is operated electrically by two dry cells contained in the case. With this instrument, vibration is eliminated, as well as variations due to the personal equation, and the results are based on uniform weights and periods of time. It is manufactured by A. Daigger & Co., of Chicago.

Another Garford Truck

The Garford Motor Truck Co., of Lima, Ohio, has announced a new two-ton model, designated as 70-B. It has heavy steel bars to guard the radiator and a heavy steel bumper bolted to the front cross-member of the frame. The rear springs have a three-point forward shackle. Worm drive is used. Special attention has been given to easy control and to comfort of the driver. The steering is right-hand, and the control is in the center.

Calculator for Reinforced Concrete

A handy calculator for making computations in the design of reinforced-concrete slabs, beams and girders, known as the "Composite Calculator," is being offered by Kolesch & Co., 138 Fulton St., New York City. It consists of a square disk with circular scales and annular windows through which appear the scales of a concentric disk.

The markings are such that the concrete calculations are based on the straight-line formula and joint-committee recommendations. In addition to the work noted, the device can be used in directly comparing the relative sizes of various wood and concrete shapes, and for ordinary slide-rule service.

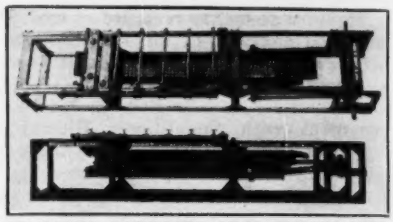
Contractor Devises New Car Unloader and Loader

An Ohio contractor, C. A. Perfect, of Sunbury, had to deliver a large quantity of stone on roadwork in limited time, and, after trying various ideas, designed the equipment shown here, which is now regularly made and sold by the Sunbury Manufacturing Co., Sunbury, Ohio. The scheme employs a bucket elevator carrying stone from a reciprocating-bottom feeder, placed under the railroad delivery track, to an elevated bin supplying wagons or trucks.

The feeder consists of a 10 x 12-in. steel trough 10 ft. long, placed below the track and bolted between the ties. The bottom is moved on oiled roller bearings back and forth about 11 in. by a crankshaft and connecting-rod. About 50 strokes a minute are made. The end of the trough next to the conveyor is open and discharges to a feed hopper; the other end is closed. Conveyor and feeder are operated by an 8-hp. gasoline engine. By setting the outfit up so that the elevator discharges over the track and the feeder is in an open space with a low hopper over it, a loader from motor truck to car is provided.

New Shaker Gravel Screen Is Compact

The compact shaker sand-and-gravel screen, 18 ft. long, 3 ft. 2 in. wide and 3 ft. 8 in. high, shown in the photograph, has a daily capacity of 400 cu.yd. It is of steel construction, self-contained and readily portable, as it weighs but

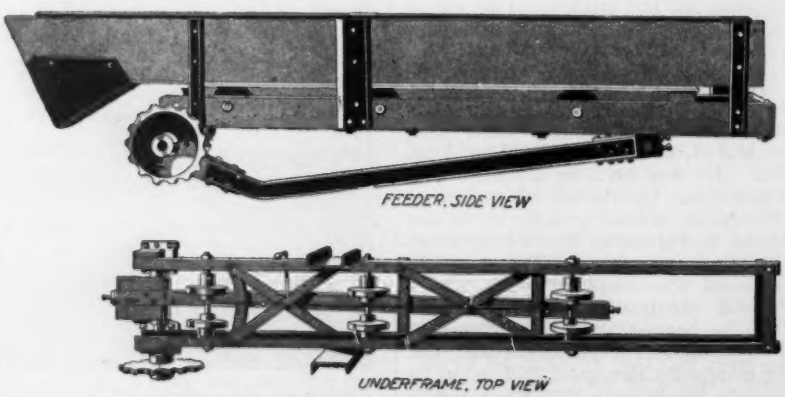


SHAKING SCREENS ARE CLOSE AND UNDER SPRAY

3600 lb. equipped with the spray washer. The top, of 2-in. mesh, takes the over size; the second is of ¾-in. mesh; the third mesh is 4 per in. and is for roofing gravel; the fourth is 10 mesh for torpedo sand; and the last, of 24 mesh, takes fine sand. The screens, which are made in 400- and 600-yd. units by the Excavating and Screening Machinery Co., Minneapolis, operate at approximately ½c. per yd. for power.

Small Concrete Mixer Made for Paving

A new mixer has been produced by the Ransome Concrete Machinery Co., of New York. It is called the "Bantam Paver" and is especially intended for paving work on alleys, long driveways and small jobs generally. It handles a one-bag batch and has an open-end pivoted hopper with quick-dumping bar. The hopper hoist has an automatic stop, so that it does not need to be watched all the time by the operator. There is used a 10-ft. distributing chute, swinging through a half-circle; its slope may be made steep, since the mixer end is elevated 4 ft. This mixer is equipped with a 6-hp. engine and is self-propelled.



FEEDER IS BOLTED BETWEEN TIES